MEDICAL AND PROPHYLACTIC SAFETY OF SPACECRAFT CREWS

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Medical and prophylactic measures to ensure the safety of spacecraft /3* crews constitute a system of procedures directed at the preservation of the health and high level of working ability of cosmonauts; the prevention of illness, trauma, intoxication, radiation and other types of damage, as well as other functional disturbances produced by the action of flight factors; the timely discovery (diagnosis) of diseases and conditions, effective treatment of patients wounded and injured by harmful substances during the period of preparation, during the flight and following return to Earth.

Medical-prophylactic measures include the following:

1. Preflight procedures:

- discovery of latent illnesses and insufficiencies of compensatory mechanisms in the organism of the cosmonaut during the process of selection and preparation for flight;

- preflight sanitation, execution of quarantine or observational and other antiepidemic measures;

- preventive operational interventions;

- determination of individual sensitivity of cosmonauts to medicinal substances.

2. Inflight procedures:

- prophylactic, diagnostic and medical procedures aboard the spacecraft during the flight;

- preparation for and execution of evacuation to Earth;

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*Numbers in the margin indicate pagination in the foreign text.

- execution of medical procedures intended to increase the resistance of the organisms of the cosmonauts to the effects of flight factors during the launching and landing (splashdown). /4

3. Postflight procedures:

- medical observation and rendering of medical assistance to the crew members after the flight;

- organization and execution of quarantine and observational procedures following the flights to other planets;

- medical observation of the cosmonauts and the development of measures for rapid readaptation of the crew members following a flight.

At the present time, a certain volume of experience in ensuring the medical safety of space flights lasting up to 18 days has been gained, and a number of measures have been worked out for the medical and prophylactic safety of longer space flights, by means of experiments which simulate the effects of space flight factors in terrestrial laboratories. These include experience gained by medical researchers under terrestrial conditions, simulating flight conditions and predicting morbidity with the aid of computer technology.

Preflight Procedures

The procedures carried out in the preflight period have ensured improved performance of flight tasks by cosmonauts, and have prevented the outbreak of illness in flight. Consequently, the task of selection and preparation of cosmonauts for flight, preflight sanitation and antiepidemic measures have been performed correctly. In addition, the sensitivity of the organism of the cosmonauts to medicinal substances included in the medicine chest aboard the spacecraft has been carried out. To prevent respiratory and adenoviral diseases, it has been found to be sufficient to limit the contact of the service personnel with the cosmonauts for one week prior to the flight, to perform daily examinations, to relieve those who become ill or appear to be becoming ill of their responsibilities, to use protective measures, to perform constant disinfection of the area, etc. /5

The need to protect individuals participating in long flights against compensated, latently developing ailments and insufficiencies of functional capacities of the organism will require further improvement of the procedure of selection and examination of cosmonauts (P. V. Buyanov, A. V. Galkin, V. G. Terent'yev et al., 1966, P. V. Buyanov, V. G. Terent'yev, 1967, T. N. Krupina et al., 1969). The frequent affliction of individuals working at the Poles with acute appendicitis during expeditions to the Arctic and Antarctic (5-10%), cases of operative treatment of severe appendicitis under difficult conditions (Doctor L. Rogozov's operation on himself), and reports (M. Grishinoy, 1961) make it justifiable to raise the question of sanitation and especially preventive operations (appendectomy, tonsillectomy) before the flight (no less than six months in advance).

Cases of infectious hepatitis in Antarctica after three months of winter (G. A. Barashkov, 1961), as well as the development of severe respiratory diseases in flight and flight-simulation experiments on the ground, pose the question of the necessity for stricter observation and quarantine. The sanitation process must involve tests for carriage of bacilli, general hygienic and antiepidemic measures, care of the teeth and gums, etc.

The principal role in preflight preparation must be played by medical preparation of the cosmonauts in order for all necessary medical and prophylactic measures to be carried out, since there will not always be a doctor among the crew. /6

The program for medical preparation can be organized only after solution of problems of predicting morbidity aboard the craft, the scope of the medical supplies and the examination of the possibility of medical manipulation in a state of weightlessness.

Prophylactic, Diagnostic and Medical Measures Aboard Spacecraft

The following are necessary to solve these problems:

- prediction of the morbidity of the crew members;
- determination of the possibility of medical manipulations in a state of weightlessness;

- prediction of the volume of medical equipment aboard the spacecraft.

Prediction of Morbidity of Cosmonauts in Flight

To solve this problem, the following have been performed:

- study and analysis of morbidity of individuals from certain age groups living under ordinary conditions on Earth;

- study and analysis of morbidity among small isolated groups in the Arctic, Antarctic and aboard submarines;

- study of reactions and morbidity of subjects under conditions simulating space flight on Earth;

- study and analysis of morbidity and physiological reactions of cosmonauts during space flights;

- prediction of probable morbidity among small groups of from 1-15 individuals isolated for periods from 1-12 months.

The studies have shown that various factors of the environment act on persons who are living under special conditions. Under the conditions that prevail when living in a small space, the members of a group are subjected to the influence of many unique factors which largely determine the nature and the characteristics of morbidity. These include the following: prolonged isolation, prolonged neuro-psychic stress, deterioration of hygienic conditions, changes in the light rhythm and daily schedule, the nature of the diet, etc. In addition, space flight is accompanied by many specific factors (radial, angular, shock accelerations, radiation, vibration, weightlessness, etc.). Nevertheless, flight factors and their simulation on Earth can predispose the human organism to the same kind of illnesses which have been encountered under conditions at the Arctic and Antarctic (L. Ye. Ponomarev, 1957; G. A. Barashkov, 1961). /7

A certain degree of interest has been generated by studies of the influence exerted on man by flight factors as simulated in terrestrial laboratories. These include, in particular, experiments involving studies of the influence of prolonged hypokinesia, relative isolation and sensory deprivation.

F. D. Gorbov, V. I. Myasnikov, and V. I. Yazdovskiy (1963) showed that monotony of surrounding conditions, similarity, poverty of external impressions are all factors which have independent significance as conditions and causes that promote the development of a state of stress and fatigue. O. N. Kuznetsov and V. I. Lebedev (1965, 1968) and O. N. Kuznetsov, 1969, working under conditions of sensory deprivation, discovered the pseudopathology, in particular, of exteriorized reactions, schizophrenia, hypomaniacal syndrom, situational illusions, etc. The authors state that on space flights, as in the experiments simulating them, it is possible to have development of reactive-isolational psychic disturbances: hallucinosis, paranoia and depression. /8

Neuro-psychic reactions and disturbances (fatigue, over-fatigue, reactive state, neurotic reactions, asthenic condition, etc.) have also developed during long stays by individuals (up to 62-100 days) in a state of hypokinesia (M. B. Umarov, 1962; D. I. Ivanov, V. B. Malkin et al., 1967, T. V. Benevolenskaya, M. M. Korotayev, T. N. Krupina et al., 1967; 1969, I. A. Maslov, 1968; A. G. Panov and V. S. Lozin, 1968).

During the course of hypokinesia, as well as during emergence from it, significant changes are seen involving the neuromuscular apparatus and the coordination of movements. In particular, there is a deterioration of muscle tone, the strength of the wrists and the decrease in the volume of the extremities (T. N. Krupina, A. Ya. Tizul, 1968; T. N. Krupina et al., 1969). Together with the disruptions of motor functions, there is also a decrease in the amount of calcium in the bones during hypokinesia (Ye. P. Byuryubkov, L. I. Kakrin et al., 1967), and a disruption of the water-salts and protein metabolism (T. N. Krupina, G.P. Mikhaylovskiy et al., 1969). These changes may be accompanied by the development of pathological processes in the bones. During brief weightlessness, disturbances in the activity of vestibular apparatus and the proprioceptors as well as the interaction of the analyzers have been observed, forming the basis for the development of a complex of symptoms indicating sea-sickness or motion sickness (Ye. M. Yuganov, 1963; Ye. M. Yuganov, A. I. Gorshkov, 1964; Ye. M. Yuganov, I. I. Kas'yan, M. A. Cherepakhin, A. I. Gorshkov, 1962 et al.). According to the data of Ye. I. Chazov, V. G. Ananchenko, 1963 and A. D. Anashkin (1969), hypokinesia is

accompanied by an increase in the activity of the anticoagulant system of the blood, increase in the content of blood heparin, the tolerance of the plasma /9
to heparin and the fibrinolytic activity of the blood, which could be disadvantageous in the event of a hemorrhage in flight.

All of the investigators note that hypokinesia on Earth and in space, even for a short flight (up to 5 days), leads to development of detraining of the cardiovascular system, and a deterioration of its regulation by the nervous system. There is a drop in arterial pressure, lability of the pulse, a slowing down of the restoration of functions following specific physical stresses, a decrease in the ability to withstand a passive orthostatic test, revealing the inadequacy of antigravitational mechanisms, a drop in vascular tone, etc. (P. V. Buyanov, A. V. Beregovkin, N. V. Pisarenko, V. I. Slesarev et al., 1966; P. V. Buyanov, 1967; G. V. Benevolenskaya, M. M. Korotayev, T. N. Krupina et al., 1967; P. V. Buyanov, A. V. Beregovkin, N. V. Pisarenko, 1967).

Hypokinesia of the intestine is a very unfavorable factor. It has led to constipation, stagnation of the blood in the hemorrhoidal veins, development of hemorrhoidal nodes, and hemorrhaging from the latter. The combination of intestinal hypokinesia, functional dyskinesia of the bile ducts, constipation, urination (with limitation of the use of water) together with disruption of water-salt metabolism may be the cause of cholelithic and urolethic disease. The significance of dyskinesia in the development of severe appendicitis, cholecystitis and so on must not be excluded.

Hypokinesia is accompanied by a change in the reactivity of the organism, and an increase in the activity of microflora and abscesses and other skin ailments develop (I. G. Popov et al., 1967; G. P. Mikhaylovskiy et al., 1967). In addition, microbiological and imunological studies have been performed on short flights, which have shown that there is a retention of tissue trans- /10
plants and their ability to survive, as well as a lack of dangerous variations in the vital activity of microorganisms (N. N. Zhukov-Verezhnikov, I. N. Mayskiy et al., 1961, 1962). When individuals have lived under conditions of hypokinesia, they have developed dental problems: carious cavities, various

congestive phenomena in the areas where the gums and teeth meet, a decrease in the cortical layer of the lower jaw, destructive changes in the teeth (T. V. Nikitina, 1970; G. M. Ivashchenko, 1969). The possibility of development of neurotic states in the case of operators in the man-machine system have been observed (F. D. Gorbov et al., 1966).

In conjunction with the fact that the range of illnesses characteristic of extremal conditions is quite extensive, and the times of their possible development have not been determined, it has become necessary to calculate (using Poisson's law) the occurrence of the most probable ailments depending on the number of people and their exposure to these conditions (G. L. Yaroshenko et al., 1967).

The least probability which must be taken into account depends on the danger which is posed by a particular ailment. The more dangerous it is, the less necessary it is to consider the probability of its development and, on the other hand, the smaller the threat posed to health and working ability by a specific ailment, the greater the possibility that its development may be disregarded.

The results of mathematical prediction of morbidity have been obtained in model experiments, and have also been compiled on the basis of morbidity of cosmonauts during space flights. An analysis of all the material has shown that essentially the data of the predictions were justified during long experiments and partly by short flights. We know that all of the cosmonauts have successfully withstood flight conditions. It is true that some of them felt /11
a sensation of a flow of blood to the head on entering orbit, as if they were upside down, and also experienced vestibular difficulties during the period of adaptation of weightlessness. Some of the American astronauts (aboard the "Apollo-7" and "Apollo-8" spacecraft) experienced respiratory diseases during flight. Almost all cosmonauts experienced symptoms of skin irritation at the points where sensors were applied, irritation of the mucus membranes of the eyes and nasopharynx (Yu. M. Volynkin et al., 1962, 1964, 1965; Yu. G. Nefedov et al., 1969).

However, the data for prediction must be considered as preliminary. They must be subjected to further refinement. In the opinion of V. V. Parin et al. (1965), the concept of variable probability of morbidity must be employed in these cases. The diseases which could occur during a space flight, in the authors' opinion, may be classified in one of the following groups:

- diseases caused by living conditions (hygienic medium, food, environment, psychological factors);

- ailments caused by the action of space flight factors (space radiation, electromagnetic fields, weightlessness);

- ailments linked to endogenic factors (autoinfection, disruption of nervous and endocrine regulation.

The authors suggest that the simultaneous action of several factors may apparently lead to the development of complex forms of illness which are serious and known on Earth. It is also possible that new diseases may develop caused by the action of still unknown space factors (V. V. Parin et al., 1965; G. L. Yaroshenko et al., 1970).

Planning the Volume of Medical Equipment Aboard the Craft /12

Planning the volume of medical equipment must be based on data regarding morbidity and the possibility of medical manipulation (examination, establishment of diagnosis, medical procedures) in the state of weightlessness aboard the spacecraft.

The first data on the possibility of medical studies in a state of weightlessness were obtained during flights aboard aircraft in a Keplar parabola (Ye. M. Yuganov et al., 1964; I. I. Kas'yan, V. I. Kopanev, V. I. Yazdovskiy, 1965). During the first space flights, the cosmonauts successfully carried out all problems, including medical tests (Yu. M. Volynkin et al., 1962, 1964, 1965; P. I. Belyayev, A. A. Leonov, V. I. Popov et al., 1966; Yu. G. Nefedov, Ye. M. Vorob'yev et al., 1969).

During the flight of a doctor aboard the "Voskhod" spacecraft, it became possible to expand the range of medical tests under conditions of space flight and to measure arterial pressure, study gas exchange, etc. (V. V. Parin et al.,

1965). During the tests it was established that while man is in a state of weightlessness the intake of medicine orally is not impeded if the medicine is given in the form of tablets (powder is inadmissible), in special tubes packed in film, etc. The use of glass ampoules or ordinary injections is not possible. Solutions of medicine must be contained in cartridge-type syringes or injectors (G. L. Yaroshenko et al., 1967).

In order to study the possibility of surgical manipulations during flights aboard aircraft in a Kepler parabola, a special transparent container was used to perform surgical operations on rabbits involving laparotomy under local anesthetic (G. L. Yaroshenko, V. G. Terent'yev, M. N. Mokrov, 1967). The /13
surgeon was fastened to his seat by special belts.

In the course of this work, it was established that it is possible to carry out operative intervention under conditions of weightlessness. Local anesthesia is recommended for use under conditions of weightlessness. To prevent contamination of the cabin when cutting tissues rich in blood vessels, it is desireable to apply clamps beforehand to stop the blood flow and to employ cloth dressings.

When the chest is opened, there is an increase in the eventration of the intestine, so that the incision must be made in stages, limiting the length of the cut. The cabin atmosphere is not contaminated when the lumine of the large or small intestine is exposed.

Proceeding on the basis of the probable morbidity and possibility of medical manipulation aboard the spacecraft (including operative intervention) according to the findings of V. V. Parin, Ye. B. Zakrzhevskiy and R. M. Bayevskiy (1965), the nature of medical assistance aboard the spacecraft must include all necessary measures including reanimation. To carry out this kind of work, it is necessary to have a doctor aboard the spacecraft. It is also desireable to have diagnostic machine as well. Some data on the development of an algorithm for such a machine are presented in a paper by R. M. Bayevskiy et al., (1966).

The principles of treatment of various diseases aboard a spacecraft thus far have remained the same as on Earth. However, the need may arise for

developing new systems of treatment in conjunction with the possibility of changes in the reactivity of the organism, including medical substances (V. V. Parin et al., 1965, 1969).

While there is still no possibility of expecting surgical assistance aboard a spacecraft, it is necessary to work out methods of inoperative treatment of acute appendicitis. The doctors who serve on submarine crews propose /14
first of all a careful selection of individuals and exclude from the trip those who have chronic appendicitis (D. P. Zuikhin, V. V. Portnov, 1963; I. Yu. Ozolin et al., 1964; Yu. D. Malyarenko et al., 1966; V. A. Katonin, 1959). In the second place, in the case of catarrhal (functional) forms it is recommended that conservative pathogenetic treatment be performed which will make it possible to avoid operations at sea. An immediate operation is required in the case of destructive appendicitis. Conservative treatment of acute appendicitis may be considered justified only when operative treatment at the location is impossible and there is no opportunity for evacuation to a hospital (V. A. Katonin, 1969). The following are recommended: bed rest, fasting (sometimes involving pumping out the contents of the stomach), cold on the stomach, antibiotics and sulfamide preparations, novocain blocks around the kidneys, atropine, parenteral injection of salt solutions and protein preparations as well as analgesics. Aboard a spacecraft, only a few of the measures required for conservative treatment may be carried out and this makes the conditions of treatment still more difficult. The position of the crew may be eased if the patient is evacuated from an orbiting (or other type) station to Earth, which is considered possible in the future by means of rescue vessels (S. A. Gozulov, L. G. Golovkin, 1966). All of these problems will require further study.

Special attention must be paid to developing measures for increasing resistance of man so that he can withstand the influence of flight factors and especially the overloads to which he is subjected on launching and landing. Various trainers for physical exercise have been developed and the possibility of using pharmacological preparations is also under study. These problems will /15
be discussed in other sections of this book.

It is necessary to consider the principles for designing medical chests (kits), selection of medicine required for carrying out medical assistance, as well as bandages, instruments and other medical supplies.

Principles for Selection and Preparation of Medical Objects and Medicinal Substances for Inclusion in Medicine Chests for Flight

In considering this problem, there are a number of questions to be answered:

- determining the nature of the medicine which must be included in the medicine chests;

- determining the nature of the other medical supplies;

- determining the rational therapeutic doses of medicines with consideration of the change in reactivity of the organism during flight;

- determining the most rational forms of medicine and packaging, suitable for use in a condition of weightlessness;

- determining ways of sterilizing medicines and preventing changes in their physical-chemical and biological properties under the influence of flight factors.

Consequently, it becomes necessary to deal with problems of space pharmacology. On the flights that have taken place in the past, types of medicines and doses were used that were employed for terrestrial conditions (State Pharmacopoeia, 1969; M. D. Mashkovskiy, 1962, 1964, 1965; B. Ye. Votchal, 1965 et al., 1965). The principles for designing medicine chests to be used on short space flights of the type that have taken place so far are set forth in a work by P. P. Saksonov et al., 1968. This paper points out the need to keep in mind the necessity for protection against radiation when selecting medicine for space flights (P. P. Saksonov et al., 1965; P. V. Vasil'yev and P. P. Saksonov, et al., 1958). /16

In selecting medicines, it is necessary to keep in mind that the medicine chest must include preparations that can be used for a variety of purposes and are most effective in their action. Preparations that reduce the

resistance of the individual to flight factors must be excluded (I. S. Gurin et al., 1968). It would be desireable to find and include pharmacological preparations that reduce the sensitivity of the organism to unfavorable flight factors.

The studies of a number of authors have shown that certain pharmacological preparations have unfavorable effects on the ability of the organism to withstand space flight factors. Thus, after taking sodiumbarbital, pentoxyl sodium and hexenal, resistance to oxygen starvation may be decreased (Ye. V. Gubler, 1952; V. B. Malkin, 1955).

There are indications (V. V. Parin et al., 1969), that phenamine and its analogs also reduce the resistance of the organism to hypoxia. After taking cystamine, an increase in sensitivity to rolling movement and high temperature was observed (L. S. Mozzhukhin et al., 1966); cystamine, aminoethylisothiuronium, 5-MOT [expansion not available] and serotonin may depress the resistance of the organism to radial acceleration (V. I. Davydov et al., 1966). Injection of cystamine (V. A. Kozlov et al., 1966) reduced the resistance of the organism to physical stress.

The negative effect on the vestibular apparatus of the streptomycin has been noticed (A. G. Panov and V. S. Lobzin, 1968). Certain antibiotics (levomycetin, streptomycin) increase hemorrhagic phenomena and leucopenia in acute radiation disease (R. V. Petrov, V. D. Rogozkin, 1958). /17

Certain preparations have been found to have a distorted effect under special conditions. Thus, following irradiation, corasole, produced a toxic effect instead of a stimulating one (V. B. Isachenko, 1956), and a distorted effect of the action of pituitrin was noticed in prolonged hypokinesia (T. N. Krupina et al., 1969).

A number of specific characteristics have been detected in the action of cardiovascular preparation. It has been shown (N. M. Dmitriyeva, 1960) that the toxicity of cardiac glucosides increases in the acute form of hypoxia and decreases in the initial form of hypoxia. Under the influence of hypoxia, the narcotic effect of ether and intranarkon may be intensified while the sensitivity to toxic doses of corazole decreases (V. Ye. Belay et al., 1968).

When adrenaline is injected during the action of overloads, there is an increase (followed by a decrease) in the pressor effect (V. Ye. Belay et al, 1967). It has been established that during the period following the action of overloads the sensitivity of the heart to strophanthin and convaside increases (V. Ye. Belay, P. V. Basil'yev, 1965; V. V. Parin et al., 1965; V. Ye. Belay et al., 1967). Vasoconstrictors (adrenaline, noradrenaline) and vasodilators (nitroglycerine, papaverine) produce a longer increase or decrease in blood pressure (V. V. Parin et al., 1965).

Several authors (V. V. Parin et al., 1969) suggested that vasodilator preparations with brief action (nitroglycerine, isadrine) should be administered periodically for training the baroreceptors of the vessels in a state of weightlessness. This proposal is under dispute. /18

Several enzymes (cocarboxylase, nicotinamide-adenine dinucleotide, cytochrome S) and certain vitamins, out of all the preparations which satisfy the energy requirements of the heart, are considered valuable (V. V. Parin et al., 1969).

Diazoline may be the best of the antihistamine and antianaphylactic substances; the use of dimedrol is not recommended due to the somnifacient effect and other side effects (A. G. Panov, V. S. Lobzin, 1968).

An abrupt decrease in the volume of information will probably cause cosmonauts in flight to show a tendency toward inhibition and depression. The necessity of retaining the physiological tone of the CNS and the prophylaxis of depression requires tests of substances like eleuterococcus (V. V. Parin et al., 1969) that promote a general tonic effect. In contrast to substances in the phenamine group, they may be taken for a long period of time and do not cause addiction, insomnia or suppression of appetite, and are also adaptogens. More powerful antidepressants that can be used once include centedrine and dexamphetamine (V. V. Parin et al., 1969). It must be kept in mind that during the flight there may be a reduction of the effectiveness of the stimulating preparations and an increase in the activity of preparations that inhibit the activity of the central nervous system (V. V. Parin et al., 1969).

Attempts at finding pharmacological substances which are capable of suppressing the development of fatigue during work under difficult conditions have not yet provided an effective solution to the problem (V. V. Parin et al., 1969).

When the "sleep-wakefulness" cycle is disrupted or when certain psychic disturbances occur on space flights, the use of tranquilizers, however, has been shown to have only a minimum negative effect on the speed and accuracy of psychic reactions and they do not reduce the arterial pressure and muscle tone, /19
for example, trioxazine and librium, while some of the "great" tranquilizers with these properties are haloperidol and triphthazine (V. V. Parin et al., 1969; A. G. Panov, V. S. Lobzin, 1968). According to A. G. Panov, V. S. Lobzin, 1968, the use of neuroplegics is undesireable, since they have a pronounced adrenolytic effect, and include substances such as aminazine, etaperazine, stellazine, phrenolone, due to the danger causing orthostatic collapse. A counter indication for the use of meprobamate and meprotan is the undesireable weakening effect which it has on the muscles. It is absolutely necessary to use soporifics in flight, especially in the event that insomnia develops in the particular situation (T. N. Krupina et al., 1969).

Preparations which basically act on the process of falling asleep, produce sleep, as close as possible to physiological, and do not affect vascular tone, metabolism, etc., will be advantageous in space. Some of the soporifics (barbital, barbital sodium, phenobarbital) cannot be used on space flights (V. V. Parin et al., 1969) due to the extreme length of the sleep which they produce (up to 12 hours), the pronounced posthypnotic effect and side effects. Some other soporifics (chloral hydrates, and barbamil to some extent) have hypotensive effects and even may cause collapse (A. G. Panov, V. S. Lobzin, 1968). Sodium oxybutyrate and hemithiamine may be recommended (V. V. Parin et al., 1969), as well as cyclobarbital and noxyrone (A. G. Panov, V. S. Lobzin, 1968).

On long space flights, it is possible for the cosmonauts to develop disruptions of metabolism. The problem of the disruption of metabolism involved in hypokinesia calls for further careful work. For active influence on the processes of synthesis in the tissues, it is recommended (V. V. Parin /20

et al., 1969) that steroids, dianabol, nerobol (and biogenic), ammonia and other anabolizers, purinic (meradine) and pyrimidinic bases (cytozine, orotic acid), and certain vitamins (B_{12}, foliec acid) are suggested. T. N. Krupina et al. (1969) obtained a positive effect in the normalization of water-mineral metabolism in prolonged hypokinesia (120 days) by administering nerobol.

When it is necessary to use anticonvulsive substances (as a consequence of impoverishment of calcium salts), hexamidine is recommended (A. G. Panov, V. S. Lobzin, 1968) since it does not have a narcotic effect.

For prophylaxis of muscular atrophy and stimulation of the neuromuscular periphery, it is recommended that the food ration of the cosmonauts include alpha tocopherol and pantothenic acid. The problem of the significance of such stimulants as proserin or oxazil remains to be discussed (A. G. Panov, V. S. Lobzin, 1968).

Among the medical preparations for surgical anesthesia and reanimation, V. V. Parin et al. (1969) mentioned myorelaxants to allow intubation and suspension of natural respiration, as well as noninhalation anesthetics (anesthesia by inhalation obviously cannot be used under the conditions that prevail aboard a spacecraft). It must be kept in mind that under the influence of flight factors sensitivity of the organism to certain narcotics may change. For example, the use of chloral hydrate following the action of overloads (V. Ye. Belay et al., 1963; V. V. Parin et al., 1965) produced an increase in the duration of narcosis, while prolonged weightlessness and hypokinesia may lead to the developments of a hypotensive effect in the case of promedol (V. V. Parin et al., 1969).

Surgical anethesia may be administered (V. V. Parin et al., 1969) through /21
the use of local administration of trimecain following premedication (for example, promedol plus scopolamine plus diprazide). It is possible to administer intravenous anesthesia with barbiturates, but they are dangerous in traumas and vascular disturbances. It is much safer to use the method of neuroleptanalgesia than barbiturate narcosis: the use of a powerful neuroleptic with the pronounced anti-shock effect of droperidol and the very active analgesic, phentanyl.

Attempts at finding pharmocological substances that will reduce the sensitivity of the organism to unfavorable flight factors have yielded some results. Thus, the sympathomimetic amines may be used for increasing the resistance of the organism to overloads. On the basis of effectiveness, preparations may be arranged (P. V. Vasil'yev, V. Ye. Belay, 1963, 1965) in descending order as follows: phenamine, adrenaline, ephedrine, noradrenaline.

The administration of thiopental-sodium and chloral hydrate in certain doses also led to positive results (P. V. Vasil'yev, V. Ye. Belay, 1963).

The positive effects of gutimine on the course of oxygen starvation of the brain has been noticed (L. V. Pastushenkov et al., 1966). With a severe degree of oxygen starvation, the use of narcotic substances has led to a prolongation of the lifetimes of animals (Yu. I. Vikhlyayev, A. I. Ulovich, 1955).

To combat the harmful effect of overloads, it is recommended to inject preparations with a vasopressor effect, which stimulates the vasomotor center (strychnine, caffeine). It must be taken into account that following the action of overloads the sensitivity to these substances decreases (N. K. Simeonova, 1965; V. Ye. Belay et al., 1967). During exhausting physical labor under conditions of additional oxygen deficit, certain antihypoxic substances were tested (for example, meditane); this led to an increase in the amount of maximum work at altitude (V. V. Parin et al., 1969). /22

One of the current problems in space pharmacology that requires solution is the finding of ways to ensure prolonged prophylaxtis of vestibular disturbances. Scopolamine in conjunction with dexedrine may be considered (V. V. Parin et al., 1969) only as a complex to be used once, since its repeated use causes a number of side effects (dryness in the mouth, disruption of accommodation, insomnia). Complex prescriptions are more effective (P. I. Syabro et al., 1969).

We know that on long space flights the doses of cosmic radiation may exceed the limits of the permissible amounts for man and the use of cystamine and strychnine is justified in this case (E. K. Grabovenko, M. F. Sbitneva, 1959).

The change in the reactivity of the organism in radiation disease has caused the specific nature of the pharmacodynamics in the victims. Depending on the period of development of radiation disease and the degree of irradiation there is an increase or decrease in the sensitivity to pharmacological preparations: these include narcotics and soporifics (G. M. Gorban', 1957; V. B. Isachenko, 1956); stimulaters of the central nervous system (P. V. Vasil'yev, P. P. Saksonov, 1958); cardiovascular preparations (V. A. Samtsov et al., 1957; G. S. Koroza, 1957; G. F. Fakhrutdinov, 1958; A. V. Lozovskaya, 1960); regeneration stimulants (I. F. Grekh, 1956); diuretic substances (P. V. Vasil'yev, P. P. Saksonov, 1958).

The question of the increase of nonspecific immunity in the cosmonauts during flight is very important. For this purpose, it is recommended that studies be performed involving polysaccharine and particularly prodigeozane (G. V. Bukharin, 1966; G. Ye. Arkad'yeva, M. A. Kashkina, 1966, G. Ye. Vaysberg et al., 1962). Dibazole may be valuable (Yu. N. Tokarev et al., 1960) as well as other preparations. /23

A medicine chest for use on flights lasting longer than two weeks must include medicine, bandages, several instruments and medical tools required for sampling urine, gases as well as skin care and so on.

The medicines should include chemical radioprotective substances, materials for treating radiation burns, cardiovascular, antimicrobial and antiviral substances (antibiotics, sulfamide preparations, etc.), gastrointestinal, analgesics and soporifics; sedatives, tranquilizers, antiallergic preparations; preparations for stimulating and activating the nervous system, substances for combatting hemorrhage and shock, means of treating motion sickness, materials for treating fatigue and preventing nausea, preparations for preventing coughing, protecting the skin, vitamins, methods of preventing muscle asthenia; supplies for rendering assistance in case of problems affecting the eyes, teeth, and antiseptics.

It is suggested that the medical preparations be sterilized prior to the flight using radioactive radiation (V. A. Kotsyurba, 1966). It is necessary to carry out tests of the methods of storing medicine in order to improve them, so

that data are available on the destruction of tablets, particularly under the influence of vibration and overloads (L. A. Semeykina, 1969).

A brief survey of Soviet studies on problems of space pharmacology and pharmacy will show that work on solving the problems facing space medicine is still far from complete. Many pertinent studies are required for the practical medical protection of space flights. /24

Postflight Procedures

The surveillance of the cosmonauts during and after flights lasting up to five days have been carried out using an extensive program described in monographs and articles (Yu. M. Volynkin, 1962, 1964, 1965; I. T. Akulinichev et al., 1963; I. M. Arzhanov et al., 1966; P. V. Buyanov, V. V. Kovalev, V. G. Terent'yev, G. F. Khlebnikov, 1966; P. V. Vasil'yev, V. V. Kovalev, V. G. Terent'yev, 1965; Yu. G. Nefedov et al., 1969; R. M. Bayevskiy et al., 1965).

Following the flights, a number of the cosmonauts were found to show signs of fatigue, an asthenic condition (V. V. Tereshkova), certain disturbances of coordination of motion, development of lability of indices of cardiovascular activity and a decrease in orthostatic stability. All of these changes were brief and vanished 1-3 days after the flight. Special attention was devoted to a study of the microbial flora of the skin, the phagocytic activity of the leucocytes, the activity of the lysozyme of the saliva, i.e., a study of the state of reactivity of the organism. It was found that there were no important changes in the micro flora of the skin and pharynx following flights lasting up to five days. Studies that were performed on short flights did not show any significant changes in the immunological reactivity (Yu. M. Volynkin et al., 1962, 1964, 1965; M. I. Kozar', 1966). According to the data of N. M. Zhukova-Verezhnikova et al., (1961), skin transplants which took place under space flight conditions were accepted well by the donors during a period of ten days following return to Earth. A slight wound in the skin of cosmonaut G. S. Titov healed well after flight. /25

Studies made following long tests simulating long space flights have shown that the immunobiological reactivity in subjects changes markedly. Following such tests, vegetative-vascular disturbances appear and there are changes in

the support and motor apparatus, as well as signs of fatigue, asthenia, abscesses on the skin, middle ear disease, aggravation of chronic processes previously well compensated (urethritis, prostatitis, etc.) (D. I. Ivanov et al., 1967; I. G. Popov et al., 1966; M. I. Kozar', 1966, etc.).

In this connection, the question arose of the increase in the nonspecific resistivity of the organism and the stimulation of natural immunity.

Following long flights, the question of the readaptation obviously becomes more serious. It is necessary to work out a schedule of physical stresses to be imposed following the flight, as well as special diet, work and rest, observational and quarantine measures, etc.

Thus, the problem of the medical and prophylactic safety of the crew members is one of the most important ones in the conquest of space by man. The handling of the principal problems in this area has only begun. A great many of the problems are still being predicted on the basis of terrestrial experiments simulating flights.

The experience of the 18-day flight has shown (N. S. Molchanov et al., 1970), that it will be necessary to carry out further testing and improvement of predictions of morbidity, scope of medical equipment, equipping the craft with medical equipment and medicine, etc. in the process of carrying out longer space flights.

I. M. Arzhanov, I. I. Bryanov, V. A. Baturenko, A. V. Beregovkin, P. V. Buyanov, V. V. Kovalev, V. M. Kondrakov, A. S. Krasovskiy, O. N. Kuznetsov, A. V. Nikitin, V. V. Nistratov, V. G. Terent'yev, Ye. A. Fedorov, G. V. Khlebnikov.

Some Results of the Postflight Examination of P. I. Belyayev and A. A. Leonov, After Their Flight Aboard the "VOSKHOD-2" Spacecraft [1].

The clinical and physiological examination was performed for a period of 3-4 days and was repeated about a month after the flight. The cosmonauts complained of mild fatigue; they showed signs of hyperemia of the mucus membranes of the nasopharynx, the conjunctiva of the eyelids and eyeballs. In comparison with the original data, they showed a loss of weight. The cardiovascular system showed lability of the pulse; it was subject to considerable acceleration with slight physical stress or a change in the position of the body. A slight increase in the intraventricular conductivity was found together with an increase in systolic index (by 7-11%), and a slowing down of the restoration of hemodynamic indices following physical stress.

The oxygen requirement was found to be above the original values by 23% in Belyayev and 14% in Leonov. The vital capacity of their lungs decreased by 8-12% and pulmonary ventilation increased by 51 and 18%, respectively.

Neurological examination revealed a slight tremor of the fingers, a pronounced orthostatic reflex in the absence of reaction of the pulse upon evocation of the oculocardiac reflex, a reinforcement of the slow bioelectric activity of the cerebral cortex. Fatigue was compensated. /27

The data from the general clinical examination of the blood and urine made three days following the flight did not show any significant differences with respect to the preflight values. An increase was noted in the excretion in the urine of chlorides, adrenaline, noradrenaline, and 17-oxycorticosteroids. The cosmonauts were subject to moderate to pronounced fatigue.

Regardless of the complexity of the flight which they had performed, the cosmonauts showed only moderate functional changes during the flight and after it.

I. M. Arzhanov, A. V. Beregovkin, I. I. Bryanov, P. V. Buyanov, S. N. Zaloguyev, Yu. V. Kamenshchikov, V. V. Kovalev, A. S. Krasovskiy, Ye. V. Kuznetsov, A. N. Litsov, A. V. Nikitin, V. V. Nistratov, Ye. A. Poruchikov, V. Ye. Potkin, V. G. Terent'yev, Ye. A. Fedorov, G. F. Khlebnikov, and G. L. Yaroshenko.

Results of Clinical Physiological Studies of the Crew of the First Multiseat Spacecraft, "VOSKHOD" [2]

The postflight examination began 15 minutes following landing and lasted for the first four days, and was repeated two weeks later. Following landing, the cosmonauts were active, excited, and complained of mild fatigue. Hyperemia of the mucus membranes of the upper respiratory pathways and conjunctiva were observed.

The body weight decreased by 2.6% in the case of Komarov, 4% for Feoktistov and 3.9% for Yegorov, due to loss of water and fat components. The neurological investigation revealed a slight tilting in the Romberg posture, tremor of the fingers, a slight decrease in muscle tone, increased tendency to prespire, while Yegorov also showed a narrowing of the arteries in the retina. No signs of disruption of vision or vestibular disturbances were found. /28

The changes on the EEG indicated a reinforcement of the processes of inhibition in the cerebral cortex. Psychological examination revealed a slight decrease in working ability (increased number of errors, prolongation of latent periods of sensomotor reactions).

Indicators of the activity of the cardiovascular system under resting conditions did not exceed the limits of a broad physiological norm. However, there was an increase in the pulse rate to 96 beats per minute for Komarov, 100 for Feoktistov, and 94 for Yegorov, together with a slight decrease in the arterial pressure of the pulse due to an increase in the diastolic.

The ability to withstand stress tests showed signs of deterioration. There was a more marked increase in the pulse frequency. The decrease in the beat volume of the heart minute circulation of the blood in a passive

orthostatic test conducted with Feoktistov and Yegorov indicated disruption of the flow of venous blood to the heart.

The study of the blood following the flight revealed the following: neutrophyllic leucocytosis and eosinopenia. The urine showed a considerable salt content (urates), individual (in the field of vision) erythrocytes, and an increase in the excretion of 17-oxycorticosteroids. Eosinopenia, increased excretion of products of hormone breakdown indicated development of a stress reaction in the cosmonauts.

The functional changes that were detected following the flight indicated general fatigue, a slight reaction to stress and a slight detraining of the organism reducing the ability to withstand tests involving stress.

I. T. Akulinichev, R. M. Bayevskiy, V. Ye. Belay, P. V. Vasil'yev, O. G. Gazenko, L. I. Kakurin, A. R. Kotovskaya, D. T. Maksimov, G. P. Mikhaylovskiy and V. I. Yazdovskiy. /29

Results of Physiological Examinations Aboard the "VOSTOK-3" and "VOSTOK-4" Spacecraft [3]

To obtain information regarding the functional state of the central nervous system of cosmonauts during flight, telemetric data, radio conversations, log books, postflight reports and conversations were used. An analysis of these materials showed that a prolonged stay under conditions of weightlessness did not have a significant influence on the functional capacities of the central nervous systems of the cosmonauts.

According to the electroencephalographic data, the first hours of exposure to weightlessness were marked by a predominance of rhythms with a frequency of 5-7 oscillations per second with a comparatively high amplitude. During the flight, the periodicity of the electrical resistance of the skin was retained, with an increase at night and a decrease in the day. This reflects the functional stability of the higher vegetative centers. An analysis of the vestibular samples, not related to the recording of the EEG, also failed to reveal any noticeable disruptions of the functions of the vestibular apparatus. Changes in the oculomotor activity in both cosmonauts

had a phasic character: at the beginning of the flight they indicated 4-6 movements of the eyes per second. At the end of the flight, the cosmonauts showed a secondary stable increase in oculomotor reactions, but this activity was much less than at the beginning of the flight. The nature of the diurnal periodicity of cardiac activity in flight did not change. According to pneumographic data, no changes in respiration were detected. No pathological changes in physiological functions were observed during the entire flight.

In the course of prolonged exposure to weightlessness (3-4 days) there /30
were changes in the nature of the EEG which indicate a change in the relationship between the stimulating and inhibiting processes in the CNS.

However, the psychic activity of the cosmonauts and their neuroregulatory abilities remained at a high level.

O. D. Anashkin

Influence of Hypokinesia, Overloads and Reduced Nourishment on the Condition of the Coagulatory System of Human Blood [4]

Under the influence of hypokinesia, the coagulatory ability of the blood is reduced (increase of heparin in the blood plasma, decrease of tolerance of blood to heparin).

Under the influence of overloads immediately following hypokinesia, it decreases still further.

G. Ye. Arkad'yeva, M. A. Kashkina

Polysaccharides -- Stimulants of Certain Indicators of Natural Immunity [5]

The authors present data on the action of glucane and a polysaccharide complex derived from actinomycetin, on phagocytosis and the leucocytic reaction. Introduction of these polysaccharides into the organism is followed by a sharp increase in the phagocytic activity of the leucocytes, with an increase in the number of leucocytes in the peripheral blood.

R. M. Bayevskiy, G. A. Berezina, Yu. V. Bukharin, S. A. Chernyayeva /31

Selection of Diagnostic Criteria in Designing an Algorithm for an Onboard Computer [6]

The article presents the results of experimental testing of one version of investigatory work on 35 healthy young persons and 35 individuals suffering from myocardial infarct, hypertonic disease and atherosclerosis.

Approximately 150 different indices were employed in the analysis of the data obtained for each of the subjects.

The number of indices of significance as diagnostic criteria is very small during rest. They are primarily the indices of pulmonary ventilation.

In a functional test with holding of the breath, highly significant differences in numerous indices were noted. Most important in this regard is the nature of the changes in the R-R interval in the electrocardiogram (cardiointervalography).

Work on a dynamograph also reveals significant differences in many indices among the healthy and sick individuals.

This work demonstrated that it is possible as a result programmed investigation to obtain a great many different indicators and to form diagnostic criteria on their basis, providing sufficiently clear differences between the norm and pathology.

R. M. Bayevskiy, Yu. N. Volkov /32

Clinical and Physiological Evaluation of Seismocardiographic Data Obtained During the Flights of the "VOSTOK-5" and "VOSTOK-6" Spacecraft [7].

The method of seismocardiography is a form of dorso-ventral ballistocardiography. The first seismocardiogram was recorded during an experiment with animals aboard the third Soviet spacecraft (Sputnik-3). This method makes it possible to study the force and coordination of cardiac contractions, as well as the duration of the individual phases of the cardiac cycle.

Aboard the "VOSTOK-5" and "VOSTOK-6" spacecraft, recording of seismograms was accomplished by means of a single channel with an electrooculogram,

so that the resistance of the electrooculographic electrodes exerted an influence on the amplitude of the seismocardiographic cycles. A clear seismocardiogram was recorded beginning with the 13-14 revolution.

Telemetric recordings of seismocardiograms were compared with seismocardiograms recorded from 38 healthy individuals and 74 who were ill. The seismocardiographic changes that were observed in the cosmonauts were compared with different deviations of the seismocardiogram in the sick individuals.

During the flight, completely regular changes in the seismocardiographic indices were observed.

The duration of mechanical systole increased in both cosmonauts during the first days of the flight; later, however, the tendency toward normalization took over. Similar dynamics are observed in connection with the electrical systole and the mechanical-electrical coefficient. The mechanical-systolic index differs from the normal values as calculated by the method of Yu. N. Volkov. The mechanical-systolic index (MSI) expresses in percent the ratio of the mechanical systole to the duration of the cardiac cycle. /33

The studies of the authors revealed that in 90% of healthy individuals the difference between the actual and ideal values of the MSI does not exceed 5%, while in the others it amounts to no more than 10%. In the case of V. V. Nikolayeva-Tereshkova, the MSI on the first day of the flight was equal to 4%, while it was 8% on the second and third days. In the case of V. F. Bykovskiy, the MSI was 8% on only the first day; it did not exceed 5% on the remaining days. The dynamics of a number of hemodynamic indices were observed, characterizing the interrelationship between the heart and vascular system and governing the state of "extracardiac" factors in the blood circulation (influx and efflux of blood). These indices as a rule have a tendency toward normalization beginning with the third day of orbital flight.

The amplitude of cardiac vibrations depends on the coordination of the contractions of the right and left heart and to a certain degree on the relationship between the stroke volume and the expulsion rate. On the first day of the flight, the duration of both osciloatory cycles of the

seismocardiogram differed slightly from the original, after which there was a gradual increase in the indices. During the first days of the flight, the compensatory reactions took place as a result of "extracardiac" factors. On the second to third days of weightlessness, changes developed in the indices of both the "extracardiac" and "intracardiac" group. By the end of the flight, the principal role in the process of accommodation of the heart to conditions of weightlessness is played by "intracardiac" factors. There is a definite phase-type nature to the reactions of the cardiovascular system to the effects of weightlessness. There is a basis for considering the changes /34
which occur in the "extracardiac" factors as an indication of the phase of unstable compensation. The phase of relatively stable accommodation, obviously, begins with the activation of mechanisms of "intracardiac" compensation.

An analysis of the results of seismocardiographic studies under conditions of orbital flight shows that the performance of accommodation reactions involves participation of both the sympathetic and parasympathetic sections of the vegetative nervous system. Initially the dominant role is played by the sympathetic reactions, since the changes in the "extracardiac" indices are primarily related to an increase in the tone of the sympathetic system. Here, as in the case of reactions to physical stress, there is a process of centralized regulation implemented through the sympathetic nerve endings.

The inclusion of "intracardiac" factors apparently indicates participation in the process of adaptation of the parasympathetic system. Initially both systems operate simultaneously, but then there is an increase in the parasympathetic effects due to the prolonged influence of flight conditions and possibly also due to the "facilitated" manner of operation of the circulatory apparatus; this finally becomes dominant. Hence, the phase of relatively stable accommodations has two periods: the period of simultaneous operation of the "extracardiac" and "intracardiac" mechanisms of compensation and the period of dominant operation of the "intracardiac" mechanisms. The authors suggest that the phase of incomplete accommodation be termed the period of predominant action of the "extracardiac" compensatory mechanisms.

Clinical data indicate that both compensatory mechanisms operate more frequently in sick people, so that a lengthening of the period of simultaneous action of these mechanisms of compensation under space flight conditions constitutes an unfavorable symptom. /35

The authors feel that the established dynamics of compensatory reactions of the circulatory apparatus cannot be considered unfavorable and that the method of seismocardiography makes it possible to check the condition of the contractile function of the heart objectively under space flight conditions.

G. A. Barashkov

Morbidity on an Antarctic Expedition [8]

During the expedition, a total of 104 individuals were under observation. The time spent in Antarctica were divided into five stages, which have different effects both on the organism as a whole as well as on individual organs and systems. In this connection, several nosological forms related to these reactions can be distinguished in the overall morbidity.

1st Stage. Summer, Autumn (January, February, March).

Attacks of stenocardia	8 persons
Arthralgia	6 persons
Disturbance of sleep	9 persons
Activation of old tubercular process	2 persons
Aggravation of lumbo-sacral radiculitis	4 persons
Severe hypertonic crisis	1 person

A number of persons on the expedition complained of headaches, pronounced dyspnea and unusual fatigue. /36

2nd Stage. Beginning of Antarctic Winter (April, May)

Patients requiring surgery	18 persons
Individuals afflicted with ailments of a therapeutic nature	53 persons (10 persons suffering from angina, pharyngitis, neuritis).

The other patients displayed problems of a uniform nature: poor sleep, general weakness, bad mood, dyspnea with unusual physical stress, pains in the vicinity of the heart, headaches, pains in the muscles and joints.

3rd Stage. Middle of Antarctic Winter (June, July, August)

During this period of time, 116 persons who were ill for the first time sought medical aid. These included the following:

18 persons spending the winter required the services of a dentist;

4 persons spending the winter suffered hypertonic disease.

The 15 individuals who had complained of heart attacks earlier were joined by 8 more.

Cases of disturbance of sleep became more frequent and there was an increase in the number of persons seeking relief for arthralgia, as well as pains in the muscles and head.

There were no cases of infectious diseases at this time.

4th Stage. End of Antarctic Winter (September, October)

The number of persons falling ill for the first time during this period decreased significantly.

11 persons complained primarily of pains in the region of the heart and joints.

However, in the case of three patients with arterial pressure that had increased, the level of the latter was found to have increased further and become stable. /37

5th Stage. Spring, Summer (November, December, January)

The characteristics of the climate in November influenced the course of the vulnerary process: there was a slowdown in the healing of wounds, infiltrate was retained longer, and the scabs that were formed were coarser and more painful.

Objectively speaking, this period was characterized by a decrease in arterial pressure, a weakening of reflexes, a drop in the immunobiological activity, asthenia and apathy.

When a new crew was brought in to relieve some of the members of the expedition, an attack of influenza broke out.

A total of 343 initial visits to the clinic were recorded during the year. These included the following:

Traumatic injuries	50 or 48%
Severe surgical ailments	12 or 11.5%
Stomatological ailments	57 or 54.8%
Infectious diseases	10 or 9.6%
Problems affecting the eyes	10 or 9.6%
Problems affecting the skin	3 or 2.9%
Problems of a therapeutic nature	201 or 193%

(in % of the total number of persons spending the winter in Antarctica)

Of the problems requiring surgery, nine cases involved acute appendicitis, constituting 8.7% of the total number of persons spending the winter; two persons suffered from renal colic and in one case there was intermittent adhesive intestinal blockage. The author suggests that it would be advantageous to perform prophylactic removal of the vermiform appendix in persons who will be going on expeditions.

Out of the total number of stomatological ailments, 31 persons suffered from carious problems of the teeth, eight suffered from pulpitis, 12 showed symptoms of amphodentos disease and six suffered from dental deposits. Decalcification of the teeth was much more pronounced among some of the persons spending the winter, since their teeth were destroyed very rapidly. /38

V. Ye. Belay, P. V. Vasil'yev

Reaction of the Organism to Strophanthin Following the Action of Transversely Directed Overloads [9]

Studies of the effect of transversely directed overloads (3, 9 and 12 units), performed on monkeys, dogs and rabbits, showed that the sensitivity of the heart to strophanthin increases following the action of overloads.

V. Ye. Belay, M. I. Bryuzgina, P. V. Vasil'yev and G. D. Glod

Influence of Hypoxia on Reactivity to Certain Pharmacological Substances [10]

Studies were performed on 480 white mice. Under the influence of hypoxia (7.5-9% O_2, 1-4 hours) the narcotic effect of ether and intranarkon was increased, while sensitivity to toxic doses of corazole decreased, indicating the development of an inhibitory process in the CNS.

V. Ye. Belay, P. V. Vasil'yev and G. D. Glod /39

Influence of Prolonged Transverse Overloads on the Functional State of the Vegetative Nervous System [11]

The studies were performed on rabbits and dogs. Intravenous (i.v.) injection of adrenaline during action of overloads produced changes in the form of an increase in the pressor effect, while after the overloads there was a decrease in the pressor effect. Intravenous injection of acetylcholine during the period immediately following overloads (15-30 minutes later) revealed changes in the magnitude of the reactions of the arterial pressure to be more pronounced.

V. Ye. Belay, P. V. Vasil'yev, G. D. Glod and V. G. Petrukhin

Mechanism of the Change in Cardiac Activity with Transversely Directed Overloads [12]

It was established that during the period of after effects of overloads, the sensitivity of the heart to strophanthin increases sharply. The degree of change in reactivity is directly related to the severity of disruptions of cardiac activity during action of overloads.

V. Ye. Belay, P. V. Vasil'yev, G. D. Glod and M. I. Bryuzgina

Reactivity of Animals to Caffeine and Strychnine During the Period of After Effects of Transversely Directed Overloads [13]

Studies were performed on rabbits (overloads of 9 units) and dogs (overloads of 12 units). The rabbits received injections of caffeine sodium

benzonate (200 mg/kg) and strychmine (0.1-0.2 mg/kg), while the dogs received /40
strychnine (70 mg/kg). The pharmacological effect of these preparations on the cardiovascular system and respiration following overloads was less marked than in the control experiments.

V. Ye. Belay, P. V. Vasil'yev, and S. P. Kolchin

Reactivity of the Organism of Animals to Narcotics Following the Action of Transverse Acceleration [14]

Under the influence of acceleration, the reactivity of the organism changes relative to narcotics. With a brief action of acceleration (3 min.) mice were seen to exhibit a decrease in the effect of chloral hydrate and an increase in the effect of thiopental sodium, evidently caused by the development of stimuli in the cerebral cortex and inhibition in the subcortical areas of the brain.

With a more prolonged (9 minutes) action of acceleration, the length and depth of chloral hydrate narcosis increased, and the action of thiopental sodium was reduced, indicating the development in the cortex of inhibitory processes at this time and of induced inhibition in the subcortex.

P. I. Belyayev, A. A. Leonov, V. A. Popov, L. S. Khachatur'yants and V. K. Filosofov

Some Dynamic Characteristics of the Operator During Tracking Under the Space Flight Conditions aboard the "VOSKHOD-2" Spacecraft [15]

The article deals with the influence of a number of factors including space flight on certain dynamic characteristics of the operator, plugged into the control system as a dynamic branch in carrying out the tracking tasks /41
assigned to him.

It was shown that the quality of the tracking by the operator in flight is reduced relative to terrestrial conditions. However, on the whole the quality of the tracking by the operator is not subjected to serious changes under conditions of actual 24-hour space flight, including the space walk by A. A. Leonov.

T. V. Benevolenskaya, M. M. Korotayev, T. N. Krupina, I. A. Maslov, G. P. Mikhaylovskiy, G. A. Petrova, K. V. Smirnov and I. Ya. Yakovleva

Influence of Hypokinesia Lasting 62 Days on the Human Organism [16]

The article presents data from a complex clinical-physiological study of six healthy men ranging in age from 23 to 26 years, kept in bed for 62 days. Three of them performed daily physical exercise. Before and after the experiment, the ability to withstand transversely directed accelerations was determined. During the experiment, the researchers examined the functional state of the central nervous system, the otolaryngological organs, the organs of the vision, the cardiovascular system, kidneys, secretory function of the stomach, morphological condition of the blood, immunological reactivity.

The disturbances that were observed in all of the systems of the organism that were studied depended on the nature of the effect and the individual characteristics of the subjects. In a state of neuro-psychic status, three periods were observed: the first (1-2 days) was characterized by increased excitement, disruption of sleep, and appearance of elements of alarm. The /42
second period (3-6 days) was characterized by physical discomfort, when pains and unpleasant sensations developed in various parts of the body. The third stage (7-20 days) involved adaptation to the conditions of the experiment. The fourth (20-35 days) was characterized by the initial asthenic phenomena (irritability, signs of disruption of the vegetative nervous regulation, disturbance of sleep). The fifth period (second half of the experiment) was characterized by increased depth of asthenia, and there were signs of hypochondriac disturbances, as well as brief periods of mild depression. The neurological state revealed an increase in the asymmetry of the tendinous and periostal reflexes, nystagmus, general muscular hypotony with development of hypotrophy of the muscles of the hips and shins, as well as hints of pathological reflexes of Rossolimo and Oppenheim. The EEG showed an increase in the excitability of the cerebral cortex with retention of its reactivity (1 and 2 days) and a decrease in reactivity and stimulatability toward the end of the experiment. Audiometry revealed changes in the auditory threshold. The vestibular vegetative stability decreased following the experiment, especially under the influence of Coriolis accelerations. The functional state of the

visual analyzer did not change during hypodynamics. There was a change in the tone of the vessels in the mucus membrane of the nose, especially in the group without physical exercise. No marked changes were observed in the function of automatism or the stimulation of the heart. There was a decrease in the filling of the extremities with blood. The reaction of the cardiovascular system to physical stress deteriorated sharply. On the first day following the experiment, this was expressed in the form of a considerable acceleration of cardiac contraction, slowing down of atrioventricular conductivity and biphasality of the T peak, and a displacement of the ST interval by as much as 1.5 mm. These changes returned completely to normal in 19 days. /43
A pronounced decrease in the orthostatic stability developed together with a deterioration of subjective tolerance to tests involving standing for 30 minutes, development of pronounced vegetative reactions, and negative dynamics of electrocardiographic indices. The changes in the phase structure of the heart cycle with an orthoprobe [sic] indicated a disruption of the contractile function of the myocardium. During the experiment, there was an inhibition of the secretory function of the stomach with a period of after effects lasting more than two months. There was an increase in diuresis, which was most pronounced during the fourth and fifth weeks of the experiment. On individual days, there was a slight increase of the content of residual nitrogen and creatinine in the blood. The ability to withstand transversely directed overloads decreased, and the indices of reactivity which had a certain correlation with clinical findings (six individuals contracted acute ailments). It was found that the organs and systems which showed various abnormalities prior to the experiment were found to be most sensitive to hypokinesia. The complex of physical exercises had a certain positive value.

Ye. N. Biryukov, L. I. Kakurin, G. I. Kozyrevskaya, Yu. S. Koloskova, E. P. Payek, S. V. Chizhov

Change in Water-Salt Metabolism Under Conditions of Hypokinesia for 62 Days [17]

The purpose of the investigation was to study the dynamics of several aspects of water-mineral metabolism in healthy young persons placed in a

horizontal position with limitation of muscle activity. Under conditions of strict bed rest for 62 days, six persons were subjected to the tests. Three /44
of them carried out exercises to train their muscles on a bicycle ergometer. The intensity of the stresses increased gradually and by the end of the second month amounted to 800,000-900,000 kg/day. Food ration was conventional, and the intake of fluid was not restricted. The quantity of water used and urine excreted was determined, together with the daily excretion of sodium, potassium, calcium, phosphorous, chlorine, sulphur and total nitrogen in the urine. The content of sodium, potassium, phosphorous and calcium in the blood was also measured.

The dynamics of water-electrolyte metabolism showed a pronounced differentiation in two phases. By the fifth to sixth week, against a background of decreasing use of liquid, a relative polyurea developed, which was accompanied until the fourth week by considerable losses of nitrous components and electrolytes with the urine. At the same time, the maximum weight loss was recorded (from 0.7 to 2.5 kg). In those subjects who carried out physical exercise, the weight loss was greatest. Beginning with five weeks of bed rest, the output of potassium, sodium and magnesium decreased. The decrease in the loss of sodium against a background of continuing polyurea led to an increase in its concentration in the plasma and a rise in the osmotic concentration of the blood. This in turn led to reflex decrease of diuresis and a restoration of the weight of the subjects beginning with the seventh week of the experiment. The rise in the calcium level in the blood, its increased excretion (up to 0.8-1.0 grams per day) in the urine and feces and the change in the optical densities of the bone structure as seen in X-rays indicated the development in the subjects of a state of relative decalcification. The maximum calcium losses were recorded during the first three to four weeks of bed rest. Dynamics of the changes in water-electrolyte metabolism made it possible to distinguish three periods of development: a period of adjustment /45
lasting three to four weeks and a period of relative stabilization of metabolic processes at a level adequate for the new functional state. These changes are the result of neuro-secereto ry regulatory processes evoked by the prolonged limitation of motor activity and a redistribution of the fluid media of the organism.

O. V. Bukharin

The Nonspecific Stimulation of Natural Resistance of the Organism to Infection by Means of Prodigiosin [18]

This paper presents the results of experiments on guinea pigs and mice, studying the influence of prodigiosin on the bacteriacidal function of the skin and the phagocytic activity of leucocytes. It was found that prodigiosin has a stimulating effect on the functions which were studied and increases the resistance of the animals to infection.

P. V. Buyanov, A. V. Beregovkin, N. V. Pisarenko and V. I. Slesarev

Prolonged Hypokinesia as a Factor Altering the Functional State of the Cardiovascular System in a Healthy Human Being [19]

The authors studied the change in the functional state of the cardiovascular system with a change from a state of hypokinesia to active mobility. Eleven individuals were subjected to limited mobility lasting 10-15 days under conditions of bed rest, while two persons were submerged in an aqueous /46 medium. The subjects were healthy men 22 to 26 years old. As preventive measures, four of the subjects performed physical exercises while two had bindings on their lower extremities. The following were recorded. Tachooscillograms, arterial oscillograms, EKG, and the phases of the cardiac cycle. A test was performed involving the measured amounts of physical stress and a passive orthostatic test.

The changes in the functional state of the cardiovascular system during the process of hypokinesia led to a decrease in vascular tone, a decrease in cardiac ejection and an increase in peripheral resistance. These changes increased for a period of four to eight days with subsequent stabilization at this level. With a transition to the ordinary mode of motor activity, stable tachycardia, increase in minute volume of circulation of the blood, decrease in the tone of the magistral vessels, change in the bioelectric activity of the heart, and a slight disturbance of the functional capacity of the myocardium were measured under conditions of rest. These changes were most pronounced during tests involving physical stress and especially when carrying out orthostatic tests. The most marked manifestation of the changes

characterizing detraining of the cardiovascular system were observed during the first two to three days of the period following their application. Individual changes lasted for 10-15 days. Considerable changes occurred in the "water" series in comparison to the "land" series. Detraining was most pronounced in those experiments where prophylactic measures were taken. The principal reason for the changes which were observed, in all probability, is the inertia of the adjustment mechanisms in the transition from one level of physical activity to another.

P. V. Buyanov, A. V. Beregovkin, N. V. Pisarenko

Prevention of Negative Influences of Hypokinesia on the Cardiovascular System of Man [20]

The purpose of this work was to study the influence of prolonged hypokinesia on the cardiovascular system of man and to evaluate various preventive measures. 17 experiments were performed, lasting 10-12 days, involving participation of 13 healthy men aged 22 to 26. Three series were organized: the first was without the use of protective measures, when the subjects were placed on a special stand in the posture which would allow maximum relaxation of the muscles, in a posture close to horizontal. In the second series, the lower extremeties were periodically compressed by means of an antioverload suit. In the third group, a set of physical exercises was performed before, during and after hypokinesia. Hemodynamics were studied by recording arterial oscillograms, tachooscillograms and polygraphic recording of the phases of the heart cycle.

During hypokinesia, there was a decrease in metabolic processes, a drop in the stroke and minute volumes of the blood, a decrease in the muscle tone and a certain decline in arterial pressure. During the period of transition from hypokinesia to active mobility, the most pronounced changes were seen following the first series of experiments. They consisted in an instability of arterial pressure, volume of cardiac ejection and vascular tone. An electrocardiographic study revealed pronounced tachycardia, a shortening of the P-Q interval, a lengthening of the QRS complex, a drop in the voltage of the R and T peaks. The period of stress and the period of expulsion increased.

The subjects withstood the passive orthostatic tests less well than in the original state. In one study, a syncope developed. Changes in hemodynamics under measured stress were expressed in two forms. In the first, the nature of the changes was the same as in the original state, but they were more pronounced. In the second, the hemodynamic changes were characterized by a lesser increase in the frequency of cardiac contractions, a significant reduction of the pulse pressure and stroke volume. In one subject who manifested this type of reaction, a syncope developed at the moment of physical stress. Following a second series of experiments, an examination under conditions of rest did not reveal any changes. On the basis of objective indicators, the tolerance to orthostatic tests was better than following experiments in the first series. However, binding the extremeties did not completely compensate the negative influence of hypokinesia and in one test syncope developed after standing for three minutes. The ability to withstand physical stress did not differ from the original level. After the third series of experiments, a decrease in the stroke and minute volume of blood were detected under resting conditions. The reaction of the circulatory system to the orthostatic test and the physical stress did not differ from the background levels. The results of the tests indicate the effectiveness of bindings and physical training in the prevention of unfavorable influences of hypokinesia on the cardiovascular system. Better results were obtained with the aid of physical training methods. /48

On the basis of data from the analysis of the results of 138 experiments, it was concluded that oxygen starvation leads to an increase in vascular tone, especially in individuals with reduced vascular tone in the original state. This makes it possible to use certain degree of hypoxia in order to prevent destruction of vascular tone during long space flights. In an experimental study of certain medical preparations for stimulating natural compensatory-adjustment mechanisms also gave encouraging results. /49

The use of physical exercise and binding of the extremeties are the most important measures that can be used for protection. The use of pharmacological substances and hypoxia require further study.

P. V. Buyanov

Change in Cardiovascular Activity and Function of External Respiration Under the Influence of Prolonged Limitation of Mobility (Hypodynamics) [21]

The changes in circulation, function of the external respiration and gas exchange were studied immediately following a transition by the subjects from conditions of hypodynamia to ordinary conditions. The subjects were 22 healthy men. Two series of tests were performed: with a marked limitation of mobility (first) and partial limitation of mobility (second). Examinations were performed under conditions of rest and under the influence of calibrated physical stress and a passive orthostatic test. The arterial pressure, frequency of cardiac contractions, oscillatory index, rate of propagation of the pulse wave along the vessels of the muscular and elastic types, the ratio of the moduli of elasticity, peripheral resistance, stroke and minute volume of the blood, minute volume of ventilation, frequency of respiration, maximum lung volume and partial volumes composing it, oxygen requirement, excretion of /50
carbon dioxide and the respiratory coefficient were all determined.

The changes in hemodynamics were observed in all the subjects and involved tachycardia, a decrease and an increase in arterial pressure. The nature of the changes in arterial pressure was connected not only with the degree and duration of hypodynamia, but also with individual characteristics of the subjects. The decrease in the stroke volume was observed primarily after a severe limitation of mobility or prolonged action of hypokinesia. In many cases, it was related to a decrease in the contractile capacity of the myocardium of the left ventricle. The reaction to a test with physical stress was characterized by inertia of the stroke volume or a decrease in it, significant tachycardia and an increase in arterial pressure. The period of recovery following the test was prolonged. In the case of 15 subjects, there was a decrease in the muscle tone of the arterial vessels, indicated by a decrease in the relative modulus of elasticity. The disruption of tone was more clearly evident in the orthostatic tests. The changes which were found in the hemodynamics bore a definite relationship to the degree and duration of hypodynamics. Low barometric pressure was not found to have a significant influence. The effectiveness of circulation decreased following hypodynamy

lasting more than five days. In the majority of subjects, decreased effectiveness of circulation following 30-60 days of hypokinesia was detected all during the observation period (7-17 days).

Changes in gas exchange indicated a different type of disruption of tissue metabolism during hypodynamia. No stable or noticeable changes in external respiration were recorded. /51

Changes in the regulation of cardiovascular system and disruption of vascular tone similar to those that occur under the conditions pertaining in these studies may develop during space flight, when hypodynamia acts on the cosmonauts together with weightlessness. They may have a negative influence on ability to withstand overloads. It is necessary to work out measures aimed at overcoming the negative influence of hypodynamia and particularly the preservation of vascular tone at a sufficiently high level.

P. V. Buyanov, V. V. Kovalev, V. G. Terent'yev, Ye. A. Fedorov, G. F. Khlebnikov

Results of Preflight and Postflight Medical Examination of the Crew Members of the "VOSKHOD" Spacecraft [22]

Examination conducted immediately after the flight revealed a definite decrease in working ability, slight instability in the Romberg position, tremor of the fingers, increased tendency to perspire, a definite decrease in muscle tone, speeding up of the pulse, decrease in pulse pressure due to increased diastolic pressure. The body weight decreased by 2.6-4%. Definite changes were also found in the metabolic processes, taking the form of increased energy consumption during rest, increase in cholesterol, blood urea and increased excretion of nitrous components with the urine. There was a slight decrease in the phagocytic activity of the leucocytes.

An electroencephalographic study revealed an increase in inhibitory reactions in the cerebral cortex. These tests indicate the development of /52
mild and well compensated fatigue in these individuals. Thus, the EEG of Komarov revealed decreased frequency and reduction in size of the alpha-rhythm index. In the case of Feoktistov, the EEG was characterized by an

increase in the alpha rhythm index, an increase in his activity in individual areas as well as a change in the threshold of excitability.

During the course of two to three days following landing, the cosmonauts showed hyperemia of the conjunctiva of the eyelids and eyeballs, as well as the mucus membranes of the upper respiratory pathways. Yegorov also showed a narrowing of the retinal arteries. Visual acuity in the cosmonauts did not change.

The changes which were observed following the flight were involved with phenomena of fatigue and reactions to stress. Deviations that were found had a functional nature and disappeared mainly in the course of several days after the flight. The differences that were observed in the nature of the changes had to do with individual characteristics and the quality of the preflight preparations.

P. V. Buyanov, V. G. Terent'yev

Extremal Factors of Long Space Flights and Requirements Placed on the State of Health of the Crew Members of the Spacecraft [23]

Studies conducted in recent years on the influence of space flights on spacecraft crews as well as the experimental study of individual flight factors have revealed a number of definite changes that take place in various organs and systems of the human organism.

Several flight factors, for example, overloads on take-off and landing, /53
even for a healthy well-trained organism, are close to the limit of tolerance. At the present time, we have almost no idea what degree of negative influence prolonged weightlessness can have on the organism. Simulation of certain elements of weightlessness and hypokinesia in laboratory conditions do make it possible to anticipate with a certain degree of accuracy what the factors of a long flight might do to the organism of a cosmonaut. A flight which is complicated by emergency situations would be difficult for the crew to survive.

At the present time, the search is actively going forward to find ways of overcoming the negative influence of factors and conditions of future space flights on the human organism. One such path is the working out of expert

medical requirements for the state of health of the cosmonauts when selecting them and training them for flight.

Many authors feel that when working under conditions of prolonged exposure to factors of space flight it is necessary to build up the state of one's health. The persons who show some kind of deviation in the functional state of the organism, in their opinion, are absolutely unsuitable for prolonged space flights.

This approach to the medical expertise of the cosmonauts have insufficient basis, since the organism of the majority of healthy individuals manifests certain peculiarities, some of which limit the professional activity of the cosmonaut while others have no noticeable effect upon it. Since we still have no experience in the direct observation of cosmonauts on flights lasting for a long period of time, an expert evaluation of their functional state must be governed by what various characteristics of the organism indicate regarding /54
ability to withstand flight factors that are experimentally simulated under laboratory conditions.

Our data, like the data of other authors, indicates that the state of weightlessness and limitation of mobility which are characteristic of long space flights lead to a disruption of water-salt metabolism, disturbance of polyhormonal functions and reflex regulation of the cardiovascular activity, a change in vascular tone, a decrease in ability to withstand physical stress and radial acceleration.

Adaptive capacities of the organism under condition of weightlessness, in the opinion of many authors, are limited by the decrease in orthostatic resistance, which is involved in a change in afferentation, which is primarily a result of a significant decrease in the hydrostatic pressure of the blood, its redistribution through the vascular areas and a decrease in the volume of circulation. In addition, emotional stress during space flight may promote an earlier development of atherosclerotic changes.

Prolonged limitation of mobility leads to decalcification of the bones, predisposes the individual to the formation of stones in the pathways by which

urine is excreted. The formation of concretions is linked primarily to a disruption of a water balance and a decrease in muscle activity.

A change in the gaseous medium aboard the craft may be the cause of disruption of respiratory function, causing inflamation of the mucus membranes of the respiratory pathways and intensifying latent processes in the lungs. Sharp qualitative and quantitative changes in the diet in conjunction with other flight factors may act as a positive factor for functional disruption of gastrointestinal tract, causing dysbacterial-autointoxication, change in /55
metabolism, etc.

Isolation, changed afferentation, emotional stress all promote disturbance of the neuro-psychic activity. Functional disturbances of the nervous system under these conditions may be replaced by more severe symptoms. In individuals with neuro-emotional disturbances, there is frequently observed a decrease in the resistance to radial accelerations and vestibular stimuli. Prolonged stays in a closed space under conditions of autonomic existence promote disruption of immunobiological properties of the organism.

Hence, the requirements placed by the experts on the state of health of the crew members of a spacecraft intended for making long flights must take into account first of all the effect which will be produced by the flight factors on the human organism, having certain functional characteristics, as well as the limits within which the functional characteristics will not play an important role in the ability to withstand a long space flight.

The experimental studies and the experience gained by experts such as the cosmonauts who have carried out orbital flights have made it possible to work out the basic requirements for the condition of the health of the crew with consideration of the need to perform on long flights.

Studies have shown that clinically healthy individuals have individually different levels of functional ability in the organism, which determine the ability to withstand flight factors. A condition for positive medical expert conclusions involving consideration of these functional possibilities is a /56
good ability to withstand standardized dynamic tests. The most informative of these are the influence of overloads, physical stress, massive changes in

position of the body (orthostatic tests), oxygen starvation, high temperature. At the present time, there are no uniform methodological ways of evaluating functional tests. In conjunction with the significance of the functional methods of the investigation, the medical expertise of the cosmonauts in the immediate future will have to be modified by a standardization of the stress tests related to the characteristics of space flight.

An analysis of the data obtained has shown that some of the features of the health do not serve as a counter indication to the performance of long space flights if the ability of the organism to adapt is not disturbed in the course of carrying out functional stress tests and stimulating certain flight factors.

P. V. Buyanov, V. G. Terent'yev

Some Clinical Aspects of the Selection of Cosmonauts for Long Flights [24]

Considerable difficulties are posed in selection by the discovery and diagnosis of latent ailments and functional insufficiencies of the nervous system as well as the analysis of the results of functional tests, stand tests and psychological examinations. Special attention must be paid in the neurological and psychological selection process to the choice of candidates who are best able to solve professional problems; special stress must also be placed upon evaluation of micro- and monosymptoms with consideration of a /57
detailed study of the anamnesis; a detection of latent epilepsy and the nature of reactions to stimuli; determination of resistance to decompression; clarification of the limiting psychopathological outlines of the personality; clarification of psychological compatibility; determination of reserve capacity of the nervous system for performing activity at a high level under complex environmental conditions, including emergency situations.

One of the crutial conditions for successful accomplishment of a long space flight is a good state of health and a high level of functional capacity in the cosmonaut.

A number of functional characteristics of reaction to extremal conditions is a direct counter indication to admission to participate in a long space flight.

P. V. Buyanov, A. V. Galkin, V. G. Terent'yev, Ye. Ye. Sheludyakov, N. V. Pisarenko and G. L. Yaroshenko

Some Problems in the Selection of Candidates for A Special Contingent [25]

Selection takes place in three stages: initial ambulatory selection, stationary examination in specialized medical areas and screening during the first months of professional activity.

In the initial examination, the dropout rate was high. The primary reasons for failure were ailments of the otolaryngological organs, as well as internal diseases among which neurocirculatory dystonia and vestibular-vegetative instability predominated.

In the stationary stage, the principal causes for failure were ailments of the internal organs (about half of the unsuccessful candidates), vestibular-vegetative instability, ailments of the otolaryngological organs, anomalies /58 of development and degenerative changes in the spine.

In the ambulatory examination used in the method of I. I. Bryanov, the dropout rate due to vestibular disturbances decreased considerably. A good method of evaluating behavior under different pressure conditions was "diving" in a barochamber.

Professional activity caused the development of functional changes in some individuals. Approximately 10% were pronounced unsuitable at this stage of the selection process.

G. Ye. Vaysberg, T. I. Afonas'yeva, N. I. Givental', T. N. Likina and Z. V. Yermol'yeva

Prodigosin -- A biologically Active Polysaccharide from Bacterium Prodigiosum [26].

This paper presents the results of studies of the biological effect of prodigosin.

Data are presented on the marked ability of prodigosin to increase the nonspecific resistance to infection.

P. V. Vasil'yev, V. Ye. Belay

Influence of Sympathomimetic Amines on the Resistance of Animals to the Effect of Acceleration [27]

The studies were performed using rats, mice and rabbits. Resistance to overloads could be increased by injecting sympathomimetic amines, which have a hypertensive effect.

On the basis of effectiveness, the preparations could be arranged in descending order as follows: phenamine, adrenaline, ephedrine, and noradrenaline. Phenatine does not have a pronounced positive effect. It is important /59
to determine the optimum doses and the times for injection of the preparations relative to the beginning of the action of the overloads.

P. V. Vasil'yev and V. Ye. Belay

Influence of Several Pharmacological Substances on Resistance to Overloads [28]

An analysis of the data of these authors and material from the literature lead to the conclusion that changing the functional state of the organism by means of pharmacological preparations makes it possible to increase its resistance to the effects of overloads. Thiopental sodium (30 mg/kg) increases, and in a dose of 100 mg/kg, decreases, the resistance of the organism to overloads. Chloral hydrate, in a dose of 200 mg/kg, injected 15 minutes prior to the beginning of rotation increased the resistance to overloads in different experiments by 2-10 units, while at a dose of 400 mg/kg it reduced it from 65 to 48 units.

P. V. Vasil'yev, V. V. Kovalev and V. G. Terent'yev

First Space Expedition. Medical-Biological Studies [29]

As a result of the flight of the crew of the "VOSKHOD" spacecraft, unique data were obtained which considerably expanded the knowledge of scientists

regarding the nature of the changes of the function of a number of organ systems in a state of weightlessness.

One of the important characteristics of the flight of the "VOSKHOD" consisted in the fact that it was performed without spacesuits. This considerably facilitated the solution of problems with which the crew members were faced. /60

The radiation conditions of the flight were completely favorable. As far as physiological reactions of the cosmonauts are concerned, they obviously were not determined by changes in the parameters of the microclimate but by other factors.

Clinical-physiological observations have shown that the general condition and feelings of cosmonauts during the prelaunch period were good, their working ability was high, and their reactions to external stimuli were adequate. The vegetative functions were within the limits of normal individual variation.

Prior to launch, an increase in the neuro-emotional stress was observed. The pulse and respiration speeded up. The cosmonauts withstood the overloads imposed by injection of the spacecraft into orbit completely satisfactorily. Out of the many factors that were operating at the time the spacecraft was injected into orbit, neuro-emotional stress still remained the critical factor determining the frequency of the pulse and respiration. The transition from overloads to weightlessness was smooth and "unnoticeable". No illusory phenomena were noted at this time. Following injection into orbit, there was a feeling of lightness, and the neuro-psychic stress diminished. However, the equivalent degree of physical stress on the conditions of weightlessness causes a much faster development of a feeling of fatigue accompanied by increased sweating.

Arterial pressure underwent a two-phase change. A decrease in the precision of coordinated movements was noted during weightlessness.

The ability of the eyes to resolve objects were practically insignificant in the case of V. M. Komarov, and decreased somewhat in B. B. Yegorov.

Biochemical tests of the blood revealed that there were no significant disruptions of metabolic processes during the flight. /61

After he landed, V. M. Komarov experienced difficulty in excreting water which he had drunk. Apparently this had to do with some serious disruption of the systems which regulate water metabolism.

All of the cosmonauts had more difficulty in withstanding the landing phase than they did the effect of similar overloads on a centrifuge. This may possibly be explained by the action of being weightless for 24 hours.

The physiological indicators returned to their preflight level comparatively rapidly. An increase in the performance of professional operations during the first few revolutions in comparison to the figures for ground training and subsequent decrease of these indicators on the remaining revolutions during the flight was noticed in the case of V. M. Komarov and Doctor B. B. Yegorov. The principal reasons for this phenomenon in specialists from different professions obviously must be emotional excitement, as well as insufficiently developed feelings of adjustment to work under actual space flight conditions.

One of the problems was the comparative study of the working ability of the commander and the doctor in the crew.

As a result of an analysis of the data obtained and their comparison with controlled data from ground experiments, we can assume that at the current state of development of space apparatus for working out the elements of a logical control activity it would be desireable to have preliminary special flight training.

At the end of the training cycle, prior to the flight, vestibular resistance was quite high in V. M. Komarov and satisfactory in the case of K. P. Feoktistov and B. B. Yegorov. During the orbital flight, both Yegorov and /62
Feoktistov developed illusory sensations of inverted posture with their eyes open or closed, which lasted for the entire time that they were in a state of weightlessness. They did not disturb the performance of their work and were noticed only when they concentrated their attention on their feelings. The

nature and degree of severity of illusory sensations and diziness were independent of the stabilization of the craft.

Yegorov also was subject to the development of symptoms of vestibular vegetative disturbances which somewhat reduced the level of his working ability on the flight.

Studies of the bioelectric activity of the brain and experimental psychological tests performed on the cosmonauts after the flight revealed changes which also indicated the development in them of moderate and well compensated fatigue.

Postflight clinical and clinical-physiological tests of the crew members of the "VOSKHOD" spacecraft revealed that the changes that were observed in the condition of the organism had a functional and transitional nature and disappeared mostly after two to three days following the flight.

P. V. Vasil'yev and P. P. Saksonov

Characteristics of the Reaction of Animals to Medicines in Radiation Pathology [30].

The following pharmacological preparations were studied: narcotics (ether, hexanal, urethane, etc.), stimulators of the nervous system (strychnine), diuretic substances (mercusal, diuretin), antihemorrhagic preparations (oxalic acid, sesame oil), stimulators of leucopoiesis (pentoxil), /63
local anesthetics (dicaine, sovcaine, novocaine, etc.), sympathomimetic amines (adrenaline, phenamine), respiratory analeptics (lobeline, cytitone), antipyretic substances (pyramidon, antipyrin), etc.

The changes in the effect of medicines depend on the one hand on the nature of the pharmacological preparations and on the other hand on the degree of radiation damage and the period of development of radiation sickness. In radiation sickness, diuretin has a very strong diuretic effect. The use of pyramidon, antipyrine and pentoxil during a period of severe development of radiation sickness aggravated its progress and increased the percentage of lethal outcomes. Lobeline, cytitone and corazole to some degree, for one to two days after radiation, produced a more marked stimulation of respiration.

Sensitivity to novocaine during the period of the peak of the disease increased considerably. Toxic and lethal doses of adrenaline caused a less pronounced pulmonary edema.

Yu. I. Vikhlyayev and A. I. Ulovich

Influence of Narcotics on Survival of Mice During Oxygen Starvation [31]

Urathane, chloral hydrate, chloralose, amytal sodium and caffeine have different effects on the survival of mice during oxygen starvation of a mild and serious nature, caused by injection of sodium nitrate.

With a serious degree of oxygen starvation, the use of narcotics leads to a prolongation of the life of the animals. In a mild degree of oxygen starvation the percentage of deaths among the mice increases and the course of oxygen starvation becomes worse. The most severe aggravation is caused by urathane, while amytal sodium is least effective in this regard. /64

Yu. M. Volynkin, V. I. Yazdovskiy, A. M. Genin, P. V. Vasil'yev, A. A. Gorozhankin, et al.

First Manned Space Flights (Scientific Results of Medical-Biological Studies Performed During the Orbital Flights of the "VOSTOK" and "VOSTOK-2" Spacecraft [32]

An analysis of the results of the medical-biological studies aboard the "VOSTOK" and "VOSTOK-2" spacecraft, piloted by cosmonaut Yu. A. Gagarin and G. S. Titov, did not reveal any changes which could be characterized as pathological. A speeding up of the pulse during the period prior to launching and during the period of injection into orbit, involving emotional stress and overloads, was not accompanied by changes in the EKG and the kinetocardiogram, which went beyond the limits of sinusoidal tachycardia. During the orbital flight, the frequency of cardiac contractions gradually returned to the original level. Speeding up of the pulse also accompanied the stages of preparation for landing and the braking of the spacecraft in the dense layers of the atmosphere. The nature of the respiratory movements did not undergo significant changes during the entire duration of the flights.

The behavior of the cosmonauts in all stages of the flight was adequate. Their working ability was not disturbed. The action which required precise coordination were performed without error. There were no difficulties in /65
taking food and water. On the basis of the data from the flight of G. S. Titov aboard the "VOSTOK-2" spacecraft, it was determined that ordinary diurnal rhythm of sleep and wakefulness are not disturbed under conditions of weightlessness. The frequency of the cardiac contractions during sleep reached 54 beats/minute, i.e., values which were natural for G. S. Titov during sleep under ordinary conditions. Excretion of urine under conditions of weightlessness was accomplished without difficulty. The vestibular-vegetative reactions which developed in G. S. Titov during a prolonged stay in a state of weightlessness are worthy of attention. Beginning with the fourth revolution, he developed a feeling of heaviness in the head and a pressure in the region of the superciliary arcs, as well as unpleasant sensations in the eyeballs when moving them (especially at the extreme positions). These reactions were provoked by movement of the head and looking through the window at the moving surface of the Earth. On the basis of the single examination of G. S. Titov after the flight, it is difficult to conclude whether or not vestibular reactions under conditions of weightlessness can be considered to be universal. The possibility is not excluded that the vestibular-vegetative problems could be overcome by methods of selection, special training and pharmacological influences.

The flights of the first cosmonauts made it possible for man to live and retain a high degree of working ability under conditions of space flight.

Yu. M. Volynkin, V. I. Yazdovskiy, A. M. Genin, O. G. Gazenko, I. N. Gurovskiy et al.

The First Group Space Flight [33]

In contrast to previous flight experiments, the group space flight was more prolonged, so that it was possible to obtain more complete data on the diurnal periodicity and the adaptation of the cosmonauts to weightlessness. /66

During the time that cosmonauts A. G. Nikolayev and P. R. Popovich were in a state of weightlessness, the frequency of the pulse and the EKG readings gradually returned to normal and approached the original level, indicating the onset of adaptation of the organism to orbital flight conditions. However, the pulse frequency in both cosmonauts, being increased during the period of injection into orbit and at the beginning of the period of weightlessness, reached the initial values that were observed four hours before the launch only after 12-18 hours had gone by. However, when simulating this situation under terrestrial conditions, the pulse frequency returned to the original values in several minutes. This is explained by the special effect of weightlessness.

During the orbital flight, the physiological indicators of the cosmonauts remained approximately at the same level. Variations in the factors that were studied changed insignificantly, indicating resistance of the neuro-humoral regulation of the cardiovascular and respiratory systems in the case of A. G. Nikolayev and P. R. Popovich.

During the flight, both cosmonauts observed disruption of their diurnal periodicity. Under terrestrial conditions, the pulse rate usually was higher during the second half of the day than during the first, while on the flight the pulse frequency in the second half either did not change in comparison to the first or was lower. It is possible that disruptions of this kind in the daily rhythm are related both to changes in the general schedule of work and rest as well as a specific neuro-psychic state caused by the nature of space flight. On the other hand, we cannot exclude the possibility of a specific effect of weightlessness.

Changes in the EKG. The PQ interval gradually becomes longer in the /67
course of adjustment to conditions of weightlessness. The QRS interval remain practically constant in both cosmonauts. Nikolayev's QT interval lengthened gradually, while Popovich's increased sharply on the 28th revolution, then gradually shortened again.

Isolated extrasystoles were recorded for P. R. Popovich on the 16th and 18th revolutions. He exhibited a similar phenomenon under laboratory conditions when subjected to the influence of high temperatures in a thermochamber.

The bioelectric activity of the cerebral cortex in both Nikolayev and Popovich was characterized by a gradual increase in the beta rhythm index and a slight increase in the alpha index, with a simultaneous decrease in the index of the oscillations in the rhythm up to 8 Hz. It is probable that the stimulatory process predominates in the cortex under conditions of weightlessness.

The magnitude of the electrical resistance of the skin decreased with length of stay under conditions of weightlessness, but on the second half of the flight Popovich showed a definite tendency toward an increase in this regard.

Vestibular studies and oculography. The transition from increased gravitation to weightlessness in the case of A. G. Nikolayev was accompanied by the appearance of a brief sensation of inclination of the trunk forward, after which, in his words, there was a "sensation of lightness". P. R. Popovich at the same time felt as though he were suspended and had the illusion that his body was in a position such that his head was bent forward and down. This condition persisted for about two minutes. He also noted that when he bent his trunk forward sharply, each time he felt a sensation reminescent of the sensory /68
reactions felt when straightening up or tilting back in a rotating chair.

Electrooculography during the flight revealed nystagmoid movements and asymmetry of the muscle tone of the muscles used for moving the eyeball, indicating normal function of the vestibular apparatus.

The subjective reports of the cosmonauts on entering the dense layers of the atmosphere included mention of a sensation of pressure in the region of the stomach and chest. Popovich had the sensation of a "gray mist" in front of his eyes for a short period of time during the landing stage, and he explains its development by the fact that the moment of maximum overstress came and he did not brace himself in time. The pulse frequency, like respiration, decreased and then increased again. No emotional changes were detected.

Hence, the results which were obtained during the group space flight showed that man can satisfactorily withstand a stay in weightlessness for up

to 95 hours. The changes that were observed did not appear critical, lay within the limits of permissible physiological variation and had a reversible nature.

The principal results of postflight medical tests of A. G. Nikolayev and P. R. Popovich are presented below:

- instability of the emotional state, more pronounced in the case of P. R. Popovich, with predominance of reactions of asthenic nature; speeding up of the pulse, increased arterial pressure, increase in the minute volume of blood in both cosmonauts, but more pronounced in Popovich;

- speeding up of respiration, increase in minute volume of ventilation and oxygen consumption, slight increase in basal metabolism in Nikolayev and by 41% in Popovich; /69

- pronounced changes of a neurodynamic nature affecting the bioelectric activity of the cerebral cortex, which developed in exaltation of the alpha rhythm in the central-occipital leads to a remarkable degree on both sides in the case of Nikolayev and with interhemispherical asymmetry in the case of Popovich;

- a slight decrease in the number of erythrocytes in the peripheral blood, brief leucocytosis, decrease in relative content of eosinophils and an increase in lymphcytes;

- increase in total protein and serum mucoid in the blood;

- significant decrease in the content of "disho"-positive [sic] substances in the daily portion of urine and desoxycytidinoid fraction, increase in the amount of corticosteroids and creatinine.

Following orbital flight, signs of general fatigue were noticed in them. In the case of Popovich, functional changes in the organism developed to a large degree after the flight, while A. G. Nikolayev underwent a more prolonged influence of flight factors.

Yu. M. Volynkin et al.

Second Group Space Flight [34]

The second group flight of Soviet cosmonauts occupies a special place in the series of launchings of "VOSTOK" spacecraft. V. F. Bykovskiy, aboard the "VOSTOK-5", spent about five days under the conditions of orbital flight, and at the same time the first woman cosmonaut, V. V. Tereshkova, performed /70
a space flight lasting nearly three days aboard the "VOSTOK-6".

The data which were collected indicate that both cosmonauts retained their working ability all during the active portion of the flight at a sufficiently high level. There were no complaints of deterioration of condition or painful sensations. Regardless of the sharp increase in pulse rate during the period prior to launch and at the beginning of the flight, its absolute values for both Bykovskiy and Tereshkova and for other cosmonauts did not exceed 160 beats per minute, i.e., less than the values at which disruption of hemodynamics can develop.

The respiration frequency increased and then decreased toward the end of the active segment. With transition to the state of weightlessness, the cosmonauts did not notice any unpleasant sensations or illusions. Observations of Tereshkova indicate that after three revolutions she developed a pithy mimicry, a concentrated expression, reduction of emotional feelings, and monotonic speech. Subjectively, Miss Tereshkova noticed a feeling of slight sleepiness. Her appetite decreased. Regardless of these aspects of the general reaction to flight conditions, Miss Tereshkova successfully carried out the tasks of the flight, demonstrating the possibility of long space flights by women as well as men. The dynamics of the changes in the pulse rate were recorded, with a sharp increase at the beginning of the flight, a decrease as it went on, an increase in the second half and especially before the end of the flight, observed not only in Bykovskiy and Miss Tereshkova but in other cosmonauts as well. The EKG readings for both cosmonauts essentially corresponded to the changes in pulse rate, and did not contain any signs of disruption of cardiac activity. When the changes in the respiration /71
frequency for the two cosmonauts are compared with the dynamics of pulse

frequency, we can see that they have an opposite direction for a large portion of the flight. When the pulse slows down in the first half of the flight, the respiration frequency shows a tendency to increase, and when the pulse speeds up in the second half of the flight the respiration frequency decreases.

The EEG shows an increase in the alpha rhythm index during the daylight hours which obviously indicates a sleepy condition and signs of fatigue. At this time, Miss Tereshkova noticed a feeling of sleepiness. There were no important changes in the vestibular and visual analyzers, and there was no interaction between them in these cosmonauts as in their predecessors.

For several hours after landing, Bykovskiy showed a higher pulse frequency and rate of respiration in comparison to the background values recorded before the flight. His arterial pressure was found to be elevated only during the first medical inspection. When the bioelectric activity of the heart was studied during the postflight period, in contrast to preflight data, a slight decrease in the intraventricular conductivity was observed at rest and there was a deepening of the T peak in the second and third standard leads following physical stress. A study of the bioelectric activity of the cerebral cortex in the case of Bykovskiy after the flight did not reveal any kind of pathological changes.

When studying the composition of the peripheral blood collected several days after the flight, investigators observed a slight leucocytosis with a decrease in relative content of eosinophils and lumphocytes. On the second day, the blood picture was normal. Biochemical tests of the blood revealed /72
an absence of any changes relative to preflight data. Biochemical tests of the urine revealed a considerable decrease in the "dishe"-positive substances.

On the whole, the postflight medical examination of V. F. Bykovskiy revealed an absence of any pathological changes in his organism.

When Miss Tereshkova was examined after the flight, the doctors noticed paleness of the cutaneous coverings and cyanosis of the visible mucus membranes. A study of the bioelectric activity of the heart two days later after the flight revealed an increase in the length of the electrical systole by 0.03 seconds. Respiratory arrhythmia had developed. Electroencephalography

revealed two days after the flight that Miss Tereshkova exhibited a general decrease in the bioelectric activity of the cerebral cortex, which was particularly pronounced in the left hemisphere.

The study of the morphological content of the peripheral blood revealed the following: leucocytosis, accelerated erythrocyte sedimentation reaction, considerable decrease in relative content of lymphocytes and absence of eosinophils. The results of the biochemical tests of the blood were marked by a considerable increase in the amount of residual nitrogen two and fifteen days after the flight. The number of "dishe"-positive substances in the urine was revealed by a biochemical examination to be reduced. There were no chlorides in the urine. Hence, the examination of Miss Tereshkova revealed that the changes that were found had a functional nature and reflected a state of pronounced fatigue.

Postflight medical examination of cosmonauts has revealed the absence of pathological changes in their organism both during the first hours and days of the flight as well as later, after the flight was completed. /73

S. A. Gozulov, L. G. Golovkin

Medical Assistance in Space Flight [36]

The characteristics of first aid on a space flight are governed by the following specific conditions:

- the effect on the organism of a complex of unfavorable factors;

- the presence aboard the spacecraft of a special kit of medical equipment;

- the presence of a doctor in the crew;

- the length of the flight and its purposes, the total number of members in the crew.

All of these features must be taken into account when deciding whether to include a doctor among the crew.

On a short flight, it is obvious that the need for medical assistance will be limited. On long flights, qualified assistance must be provided.

On past flights aboard Soviet spacecraft, the cosmonauts did not reveal any kind of problems which would have required special medical aid.

The problems involved in rendering this aid deserve comprehensive study.

An important problem is the possibility of predicting ailments and other deviations from the norm in the state of health of the cosmonauts.

Depending on the nature of the ailments, a system of medical assistance can be devised. The most probable ailments are those linked with insufficient /74
hygienic conditions of the medium, emotional overstresses and neuropsychic fatigue. However, severe toxic, infectious, surgical and other types of problems may develop which are not related with specific conditions of the flight. A decrease in the probability of ailments must be a goal in the selection and the preparation of cosmonauts. On future long flights it will be necessary to devise special medical kits with a variety of medical equipment for use under conditions of weightlessness. It is necessary to teach all of the members of the crew the fundamentals of space physiology and medicine.

As we gain experience aboard manned space flights, indications and counter indications will be developed for treating striken crew members or shifting patients to spacecraft intended for rescuing those who fall ill and endanger the crew.

Irreplaceable medical assistance on space flights and special medical technology will undergo further improvement and development aboard rescue craft.

G. M. Gorban'

Reactions of Irradiated Animals to Narcotics [37]

The experiments were performed on frogs, guinea pigs, rats, rabbits and dogs. The following narcotics were used: hexanal, ether, chloroform, nitrous oxide as well as a combination of hexanal with novocaine and nitrous oxide.

During the first hours following serious radiation injury, a decrease in the narcotic effect was observed, with the exception of hexanal and ether, /75
whose effect increased slightly. During the period of peak development of

radiation sickness, there was a considerable increase in the sensitivity of the animals to hexanal and ether. Ether anathesia administered during the first hours following irradiation aggravated the course of the disease and increased the number of lethal outcome.

F. D. Gorbov, V. I. Myasnikov and V. I. Yazdovskiy

The State of Stress and Fatigue Under Conditions of Isolation from External Stimuli [38]

Fatigue and stress and their differentiation were studied in experiments lasting 10-15 days.

It was found that monotony of surrounding conditions, isolation, poverty of external impressions are all factors that are of independent significance as conditions and causes that are capable of causing development of states of stress and fatigue.

F. D. Gorbov V. I. Myasnikov and V. I. Yazdovskiy

Several Functional Changes in the Human Organism During Prolonged Isolation [39]

An evaluation of the functional state of the organism during prolonged isolation was performed on the basis of data of observation of the behavior and emotional reactions, dynamics of bioelectric activity of the cerebral cortex and the results of determination of response rate in solving psychological problems.

An analysis of the data obtained revealed that a change in the functional /76
state begins at the start of the experiment, continues during the test and lasts a short time after it is over. Emotional stress during the period of preparation and during the first hours of the experiment was viewed as a state similar to that existing before a launch, whose basis lay in an insufficient preliminary adaptation of the subjects to experimental conditions. A prolonged stay under conditions of isolation produce definite changes in the bioelectric activity of the cerebral cortex. An increase in the latent period of response motor reactions toward the end of the test was revealed to be

caused by fatigue, whose first signs were observed at the same time that fatigue processes developed in the CNS (on the basis of EEG data).

The tests which were performed showed that a severe limitation of a general afferentation has a significant influence on subjects. Functional changes in the neuro-psychic sphere at various stages of the study were ambiguous.

F. D. Gorbov, O. N. Kuznetsov and V. I. Lebedev

Specifics of the Origin and Development of Neurotic States in Operators In the Man-Machine System [40]

The principal functions of man in industry constitute programming, watching machines, guidance and monitoring. On this basis, new forms of interaction between man and technology have developed. In some cases, these interactions are the source of psycho-physiological difficulties and conflicts that give rise to neuroses.

Studying the processes of regulation in the man-machine system, their /77
structure and function, engineering psychology views the human operator as one of the branches of this system.

B. F. Lomov defines three principal tendencies in the change of labor activity of man when working in automated systems. In the first place, the individual is faced with the task of simultaneously controlling an ever-increasing number of objects. Secondly, the man is isolated to an ever increasing degree from the objects he controls. In the third place, the conditions of modern technology lead to a considerable increase in the requirement for the rate of action by workers, caused by an increase in the rate of control of the processes being controlled. One of the important functions of the operator in the man-machine system is the obtaining of information regarding many processes by means of instrument readings. The transition from limited information to excessive causes unique neurotic disturbances of the higher nervous activity, which develop for example when emerging in an aircraft from clouds under difficult meteorological conditions. A characteristic example could be the severe condition that developed in flight in the

case of the 33-year old pilot L. when flying under difficult meteorological conditions. The pilot performed his tasks incorrectly. When asked by the commander about the reasons for the fact that he did not obey orders, the pilot replied: "I lost the thread of thought somehow... I don't remember anything about what I was doing... The last thing I remember was that the instrument readings were normal... It seemed that I had lost consciousness, but I did not become unconscious."

Neurological interruption of higher nervous activity in this pilot developed when the limited flow of information from the instruments was supplemented by "excess" information from objects on the ground. Under /78
difficult meteorological conditions, he tried to orient himself by the readings of the various instruments which also gave him an idea of his location. The instrument readings, from the physiological standpoint, acted as secondary-signal stimuli.

The uniqueness of the neurotic states of operators and the requirement for working expertise as applied to representatives of the operating profession makes it necessary to develop additional highly sensitive diagnostic methods of investigating these atypical and harmful forms. Recently, in conjunction with the development of experimental group psychology, special devices have been employed which produce interrelated activity.

E. K. Grabovenko and M. F. Sbitneva

The Problem of the Medical Effect of Strychnine in Acute Radiation Disease In Rats and Mice [42]

The strychnine was administered in different doses and at different times after exposure to radiation. Positive results were obtained when strychnine was used in a dose of 0.5 ml of an 0.1% solution given daily for the first 10 days following irridation. Out of 49 rats that were treated in this fashion, 17 survived while only 5 out of 49 controls remained alive.

I. F. Grekh /79

Influence of Pentoxyl on the Course of Radiation Disease in White Mice [43]

Pentoxyl has the ability to stimulate the processes of regeneration and may serve as a method of increasing the effectiveness of chemotherapeutic substances in the treatment of radiation disease and apparently other diseases as well in whose development infection plays an important role.

Ye. V. Gubler

Influence of Barbiturates on the Sensitivity of the Organism to Oxygen Starvation [45]

Experiments on mice revealed that medinal and pentothal sodium reduced the resistance of mice to hypoxia.

Barbiturates, like other narcotics and soporifics, influence the development of oxygen starvation in two different ways. On the one hand, they reduce the requirement of brain tissue for oxygen and also prevent the development of oxygen starvation of the brain. On the other hand, they can depress the nerve mechanisms which produce compensation in oxygen starvation and thereby reduce the excitability of the respiratory center, causing a premature depression of its activity. Depending on the nature of the dose of the narcotic, it may have either a positive or a negative influence on the ability of the organism to withstand hypoxia.

I. S. Gurin, B. I. Davydov, Ya. N. Divin, E. M. Panova, P. P. Saksonov and V. G. Terent'yev /80

Medical Therapy and Flight Safety [46]

This paper presents an analysis of the side effects of medical substances and their significance for further activity of pilots and cosmonauts. Questions of the consequences of medical therapy and the principles of designing medicine cabinets for aircraft are treated.

At the present time, neither aviation nor space medicine has any scientifically based data on the residual effect of many pharmacological

preparations intended for the treatment of pilots and cosmonauts as far as physiological status and working ability under experimental conditions is concerned. At the same time, however, we know from pharmacology that the physiological disturbances may develop in man under the influence of the preventive or therapeutic intake of pharmacological preparations. These disturbances may be also developed as a result of uncontrolled self treatment. It is no accident that the practice of aviation medicine excludes the use of many medicinal substances which could cause sharp functional disruptions in the organism of a pilot-cosmonaut (depression of the CNS, bone marrow, disruption of the cardiovascular system, hypoxia, etc.). Preparations that do the following can automaticaly be omitted from use before flight (or in flight):

a) lead to oxygen insufficiency, for example, produce inhibition of the respiratory center (morphine), formation of metahemoglobin (nitrite, sodium), inhibition of certain respiratory enzymes (cyanides); /81

b) inhibit the CNS (barbiturates);

c) cause sharply pronounced allergic reactions;

d) reduce the resistance of the organism to flight factors.

We know that in some individuals antihistamine preparations cause a state of somnolence or severe depression. In addition, they inhibit the vestibular apparatus, cause deterioration of the perception of signals, thereby causing a serious danger for the crew in flight. Hence, after taking antihistamine cough medicine from the opium group, the crew must wait at least eight hours before making a flight; if they have taken barbiturates (nembutal), they must wait 12 hours; anesthetics -- 24 hours; sulfamide preparations -- 48 hours; alcohol -- 12-24 hours. Failure to observe these precautions may have a negative effect on the pilot's activity and be the cause of an accident.

Thus, for example, the consequences of taking preparations from the opium group may be an inhibition of reactions, deterioration of motor coordination. When sulfamide preparations are taken, there is a decrease in the visual accuity, dizziness, deterioration of the function of the hemopoietic organs, a decline in the resistance to infection, a decrease in the resistance

of the organism to hypoxia, and a decline in working ability. The effect of cystamine is an increase in the sensitivity of the organism to dynamic flight factors. Tranquilizers reduce the ability of the body to withstand altitude factors and acceleration. It should be kept in mind that antibiotics such as streptomycin, dihydrostreptomycin may cause vestibular disturbances and a temporary weakness of hearing. /82

When streptomycin is used, dizziness has been observed. It is well known at the present time that radioprotectors (cystamine and aminoethylisothiuronium, 5-MOT and serotonin) in optimally protective doses reduce the resistance of the organism to radial acceleration. All of this indicates that failure to observe the above periods of quarantine by pilots before flying after taking pharmacological preparations may have a negative effect on their activity.

During the flight, the following medicines may be used:

- neosynephrine in the form of nose drops or by inhalation for rhinitis;

- aspirin, codeine in small doses in the form of analgesic preparations;

- antibiotics with the exclusion of streptomycin, chloromycetin and chloroamphenicol;

- stimulants: benzidrine, pervitin, caffeine, benzoate sodium.

In discussing stimulators of the CNS and noting their favorable influence, we must not forget that these preparations (especially phenamine and its derivatives) cause a paradoxical effect in 15% of the cases, i.e., instead of causing stimulation, they cause severe inhibition. In addition, prolonged and uncontrolled use of phenamine may cause addiction and lead to exhaustion of the CNS. Uncontrolled use of certain other pharmaceutical preparations may also have consequences.

Recently, both Soviet investigators and those abroad have dealt with the problem of the use of medical preparations by pilots and cosmonauts in flight. /83 This is explained by the fact that cosmonauts are subject to the action of a number of flight factors which produce diverse functional changes affecting the nervous and endocrine systems. On the basis of experimental data obtained

by Soviet authors, the possibility has not been excluded that under flight conditions the response reaction of the pilot's organism or that of a cosmonaut to a given medical preparation may be increased, reduced and even distorted. Consequently, before solving the problem of medical preparations under flight conditions, it is necessary to know the nature of their effect under these conditions. To do this, it is necessary to perform special tests in two directions:

- study the reaction of the organism subjected to the action of flight factors after taking medical preparations;

- study of the influence of preparations on the reactivity of the organism to flight factors.

Only this kind of test will make it possible to use pharmacological preparations as medical and prophylactic tools with the maximum effectiveness.

B. I. Davydov, V. V. Antipov, V. A. Kozlov, P. P. Saksonov and V. S. Shashkov

The Problem of the Use of Radio Protective Pharmacological Substances Under Space Flight Conditions [47]

The effect of cystamine and aminoethylisothiuornium was studied in mice, guinea pigs and dogs. With a joint action of overloads and radio protectors, the hypoxic effects became more severe,causing a decrease in the /84
resistance to acceleration. It is recommended that more care be exercised in prescribing radio protective compounds (especially cystamine, aminoethylisothiuornium, serotonin and 5-MOT).

N. M. Dmitriyeva

Characteristics of the Pharmacodynamics of Cardiac Glucosides With Various Initial States of the Organism [48]

Studies were performed on guinea pigs and rats. It was found that the toxicity of cardiac glucosides increases in a severe form of hypoxia and decreases in the initial form of hypoxic hypoxia. The initial degree of hypoxia is accompanied by stimulation of the volume of substances and a deep

degree of hypoxia by a lesser intensity of metabolism. The smaller the glycogen content in the myocardium, the more sensitive the animal organism is to cardiac glucosides.

N. N. Zhukov-Verezhnikov, I. N. Mayskiy, V. I. Yazdovskiy, A. P. Pekhov, A. A. Gyurdzhian, N. P. Nefed'yeva, M. M. Kapichnikov, I. I. Podoplelov, N. I. Rybakov, N. N. Klemparskaya, V. Yu. Klimov, S. N. Novikov, I. S. Novikova, R. V. Petrov, N. G. Sushko, Ye. P. Ugryumov, G. I. Fedorova, A. F. Zakharov, I. N. Vinogradova, K. G. Chamova and Ye. A. Buyko

Goals of the First Microbiological and Cytological Experiments in Space Aboard Earth Satellites [49]

The purpose of these experiments was to determine to what extent the influence of space factors influences the vital activity of unicellular organisms, primative organisms (phages), as well as cells of higher organisms (tissue cultures). The possibility of multiplication of bacteria under space /85
conditions was established and finally, the influence of space flight factors on the reproduction of organisms, especially the formation of pathological inherited changes, as well as the physical and chemical properties of cells substances responsible for the transmission of inherited characteristics (DNA).

The following facts were established: viable cells were found in cultures on a nutrient medium, using skin transplants returned from space. Reimplantation of these transplants on the same donors showed that the degree of viability of the experimental samples was identical to that of the controls. Cultures of cancer cells displayed practically the same ratio of living and dead cells, equal to the growth potential, as control samples. A morphological and immunological study of these strains also failed to reveal any kind of difference between the cultures that returned from space and the controls.

When intestinal bacilli, K-12 and A aerogenus were exposed, it was found that the number of viable examples remained practically the same as in the control; in addition, no genetic changes were observed following exposure of these microorganisms.

N. N. Zhukov-Verezhnikov, I. N. Mayskiy, V. I. Yazdovskiy, A. P. Pekhov, A. A. Gyurdzhian, N. I. Rybakov, V. V. Antipov

Microbiological and Cytological Studies Aboard Spacecraft [50]

Microbiological and cytological studies were performed in order to provide a biological indication of orbits in which the cosmonauts later flew. /86 Problems of the influence of flight factors on the cells of higher animals and man were studied and the problem of genetic effects on the cellular and subcellular levels was treated. Biological objects with different sensitivities to the action of external factors, were exposed aboard satellites and in the cabins occupied by the cosmonauts. The viability of bacteria -- representatives of the intestinal group and staphyllococci -- was studied with the aid of bioelements. Thanks to the method of mass culturing of somatic cells in a single-celled culture on glass, cells from the human body were employed (cultures of Hell cancer cells, fibroblasts and amnionic cells). To study the viability of the tissues of the human organism, skin transplants were employed. The studies revealed that among the factors involved in space flight in the orbits studied there are none which would have a serious influence in terms of damaging cells through their primary action on them.

Genetic studies were based on an examination of the lysogeny of bacteria of *E. Coli* strain as the most sensitive indicator of genetic effectiveness of ionizing radiation. The experiment failed to turn up any factors which damaged the genetic base of the lysogenic bacteria.

N. N. Zhukov-Verezhnikov, I. N. Mayskiy, V. I. Yazdovskiy, N. P. Pekhov, N. I. Rybakov, N. N. Klemparskaya, A. A. Gyurdzhian, G. P. Tribulev, N. P. Nefed'yeva, M. M. Kapichnikov, I. I. Podoplelov, V. V. Antipov, I. S. Novikova and V. Ya. Kop'yev

Problems of Space Microbiology and Cytology [51]

To study the vital activity of terrestrial microorganisms when exposed to space, 18-hour agar cultures of *E. Coli* were used as typical in their properties. /87 On the second and subsequent Soviet spacecraft, butyric bacteria were exposed in special devices called bioelements. These devices were intended

for recording the formation of gases in the course of the vital activity of the microbes and signalling this fact to Earth. The data which were obtained indicated that the stay of the bacteria as well as bacteriophages in space had no effect on their vital activity.

As the original cell culture, a seven-day clone culture of Hell cells was used -- normal human fibroblasts and amnionic cells, exhibiting high radio sensitivity. All of the original cultures was subjected to a prolonged cultivation (lasting more than a year). Viability and fundamental biological characteristics of the cultures were unchanged. Skin flaps, taken from three donors, also retained their viability. By means of such microbiological and cytological objects, the orbits along which Yu. A. Gagarin and G. S. Titov travelled were studied. It was found that the tolerance to space flight factors of higher animals can be explained not only by the adaptive-compensatory abilities of the organism as a whole but by the initial immunity of its cells.

To study the genetic consequences produced by the action of space flight factors, lysogenic bacteria (*E. Coli*, K-12 λ) were used which have the ability to produce phages after the action of ionizing radiation. The stay of the lysogenic bacteria in space had no affect on their ability to produce phage particles. The 25-hour flight in orbit performed by spacecraft of the /88
"VOSTOK" type also has no effect that can be noticed as far as the genetic process is concerned.

D. P. Zuikhin, and V. V. Portonov

Treatment of Acute Appendicitis in Submariners at Sea [52]

The resources and abilities of the surgical group aboard a submarine are very limited. The problem of administering total anesthesia under these conditions has not yet been solved. The sole moral criterion which governs the performance of a major operation aboard a submarine at sea is a necessity to prevent mortally dangerous complications in the patient.

Together with surgical treatment, some physicians connected with submarines use a conservative treatment for patients with appendicitis. The

method of conservative treatment deserves wide attention. In the case of acute appendicitis developing on a voyage, the doctor watches for its initial signs, when the process in the appendix is in the phase of functional changes, when it is possible to carry out successfully conservative pathogenetic treatment, making it possible to do away with the need of an operation at sea. When destructive appendicitis is suspected, appendectomy is required at once. In the case of mildly exhibited symptoms of acute appendicitis, conservative treatment may be applied.

Submariners who contract acute appendicitis at sea and are given conservative treatment, are given operative treatment in normal fashion following return to base.

By using a local anesthetic, there is no need to ignore the method of intraabdominal hexanal anesthesia, applied in 1940 by I. S. Zhorov, I. V. Danilov et al. The convenience of this method lies in the fact that it does not require special apparatus or assistants. /89

D. I. Ivanov, V. B. Malkin, I. N. Chernyakov, V. L. Popkov, Ye. O. Popova, A. B. Flekkel', G. A. Arutyunov, V. G. Terent'yev, P. V. Buyanov, N. A. Vorob'yev and G. G. Sturua

Influence on Man of Prolonged Stay under Conditions of Reduced Barometric Pressure and Relative Isolation [53]

The purpose of this experiment was to study the influence of prolonged (up to 30 days) stay of man in small-volume chambers under conditions of rarefaction to altitudes of 3,000, 5,000 and 7,000 meters, respectively, with a pO_2 in the air equal to 150-200 mm hg, to determine the nature and direction of the functional changes in conjunction with destruction of normal diurnal schedule.

Two men were placed at the same time in a barochamber fitted with a regeneration system and having a useful volume of 5 m^3. Each of them had a daily routine worked out for him. The duration of the experiments varied from 10 to 30 days. The investigators studied the EEG, EKG, arterial pressure, reactions of the cardiovascular system to physical stress, energy consumption

by the organism, protein fractions in the blood plasma, content of 17 oxycorticosteroids in the urine. A detailed clinical physiological examination was performed.

Changes were observed in 10 24-hour experiments at an "altitude" of 3,000, 5,000 and 7,000 meters did not go beyond the limits of permissible boundaries. In many cases, there was a change in the position of the electrical axis of the heart. The changes that were observed in the EEG had an individual nature and did not go beyond the limits of the values that were recorded under conditions of ordinary activity of the subjects. The rarefaction factor did not have a definite influence on man. Functional changes were largely dependent on the duration of the stay at altitude. After 14-15 days, there was an increased irritability of the cardiovascular system: tachycardia, pronounced reaction to the orthostatic tests. The increase in the 17-oxycorticosteroid content in the urine, of albumins in the plasma and several items of data involving visual functions indicated that fatigue was developing by this time. A comparison of the two schedules showed a clearly pronounced diurnal periodicity of the functional changes under a schedule approximating the normal and a smoothing or even distortion of the diurnal periodicity of the observed functions under a less favorable schedule. The experimental material obtained provides a basis for assuming that wakefulness at night is unfavorable for retention of working ability. /90

A considerable drop in the general activity of the subjects led to a decline in their gas metabolism by 20% or more relative to the original value. The protein, fat and carbohydrate metabolism did not show any important changes.

During the period of afteraffects, there were several marked features in the neurological state, signs of hypotomy and symptoms of detraining of the cardiovascular system.

G. M. Ivashchenko /91

Stomatological Safety of Space Flights [54]

In solving the problems of maintaining the organism at a required physiological level which will ensure viability, safety and working ability of the crew members during all parts of a space flight, stomatologists are faced with complex tasks and problems which must be solved in the course of complex examinations of space medicine in general.

The principal problems of space stomatology are the following:

1. Development of stomatological indications and counter-indications for the acceptance or rejection of candidates;

2. Development of methods of sanitation of the organs of the oral cavity and teeth in the selected candidates;

3. Determination of the most probable stomatological ailments which might develop under conditions of space flights of varying durations;

4. Compilation of recommendations on the scope of the medical and preventive measures for the crew members during flights lasting for various periods of time;

5. Several problems of the nutrition of the cosmonauts involving the need to ensure the necessary chewing stresses on the teeth and jaws of the individual;

6. Compilation of a practical guide (handbook) describing stomatological aid to be given to the crew during a space flight;

7. Development of a program for preparing the cosmonauts on the basis /92
of stomatological self- and mutual-assistance.

V. B. Isachenko

Use of the Reaction of the Organism to Barbiturates and the Waking Effect of Corazole Following General Irradiation [55]

Following irradiation of animals with large doses (500 and 1,000 r), corazole was found to have a toxic effect instead of a waking effect. With

sharply pronounced symptoms of radiation disease, barbiturates (nembutal, barbamil and thiopental) cause definite deterioration of the condition.

I. I. Kas'yan, V. I. Kopanev, and V. I. Yazdovskiy

Reactions of Cosmonauts Under Conditions of Weightlessness [56]

This paper is an attempt to analyze a number of physiological reactions of cosmonauts who were under conditions of brief (training flights aboard an aircraft in a Kepler parabola) and prolonged weightlessness (flights aboard the "VOSTOK" type spacecraft).

The duration of brief weightlessness was 35 ± 5 seconds. On each flight, the cosmonauts were subjected to the action of weightlessness while carrying out from three to six "vertical climbs". During the flight, the cosmonauts either sat in a seat held in place with belts or were in a free state.

The following were recorded during the flight: the biocurrents of the heart muscle (EKG), arterial pressure, pulse frequency and respiration; /93
coordination of movements were studied by means of "writing tests" and work on a special coordinograph.

The sensations of the cosmonauts under conditions of brief weightlessness did not change significantly. When the cosmonauts were firmly attached to their working area, they carried out the coordination tests without any particular difficulties. When able to move freely about the cabin, they encountered difficulty in carrying out tests. Under conditions of weightlessness, the pulse slowed down, as did the respiration frequency, and the arterial pressure dropped. The reactions of the cosmonauts showed definite influence of individual characteristics. During the orbital flights, the cosmonauts showed prelaunch reactions. In making their transition from increased weight to weightlessness, they suffered brief illusions. Their working ability at this time was not disturbed significantly. A study of the vegetative functions revealed the following: a regular slowing of the pulse, speeding up of respiratory movements and slight changes in the EKG which were the consequence of a change in the electrical axis of the heart and to some extent to disturbances of metabolic processes in the myocardium. There

was a considerable variation in the physiological indices and a slow return of the latter to the original level. Conclusions were drawn regarding the need to perform training flights on a Kepler parabola and to use the results obtained in selecting and training cosmonauts.

The data which were obtained make it possible to conclude that weightlessness has both direct and indirect influence on the human organism. Two ways exist for preventing negative influence of weightlessness: development of methods of increasing the resistance of the organism and technical improvement of the spacecraft themselves.

V. A. Katonin /94

The Problem of the Tactics To be Used by a Ship's Doctor in the Case of Acute Appendicitis on a long Voyage [57]

Schilling (1953), Schmidt (1945), Norman (1959) and Rice (1964) et al., from the medical service of the US Navy propose a conservative method of treatment of acute appendicitis on autonomous voyages aboard vessels and submarines. Although a significant amount of experience has been gained in connection with the surgical treatment of severe appendicitis aboard vessels and submarines, this kind of treatment remains a complicated business. Therefore, in the absence of prepared personnel, D. P. Zuikhin, V. V. Portnov, Yu. D. Malyarenko, Yu. D. Tselishev recommend the use of the tactic of "defensive observation" and operating as the process progresses and in cases with severe clinical picture. Observations are carried out either without treatment (bed rest, withholding of food, local administration of cold), or else antibiotics, atropine, intravenous injection of novocaine solution or perirenal blockade are used. Then, if no definite improvement is observed in the course of four to six hours of treatment, the operation must take place; if there is improvement the conservative treatment is continued. The experience of ship's doctors indicates a need for avoiding the use of medicines in mild forms of acute appendicitis, since treatment promotes the smoothing of the clinical picture, sometimes concealing destructive changes in the appendix. When using the tactic of "defensive observation" 70.4% of the appendices that were removed during the voyages turned out to be destructively

changed. Complications were noticed only in those patients who either asked for medical assistance too late or were treated too long conservatively. Therefore, conservative treatment may be justifiably used only in case of /95
catagorical impossibility of operating on the patient, lack of a doctor with surgical preparation, and under stormy conditions. In those cases when the doctor must carry out conservative treatment of acute appendicitis, it must be complex. Even with a correct complex conservative treatment of acute appendicitis, serious consequences may develop (diffuse peritonitis, abdominal abscesses, etc.), which is supported by the practice of autonomic voyages.

Hence, conservative treatment is permissible only in cases of impossibility of performing operations or evacuating the patient to a hospital. Appendectomy on a voyage must be carried out under the strict control of Navy doctors who have the appropriate training.

M. I. Kozar'

Influence of Space Flight Factors on Indicators of Natural Antibacterial Resistance of the Organism [58]

This paper is devoted to a study of the influence of extremal influences on the natural antibacterial resistance of the organism.

As an indicator of natural resistance of the organism, the author used the bacterial function of the cutaneous covering, the lysozymic activity of the secretions of the digestive system organs and the bacteriolytic (lysozymic) activity of the blood. A comparative study was performed of the content of lysozyme in the secretions of the digestive gland and the blood of human beings and animals under normal conditions. /96

Studies were performed in a course of long observation on individuals (260 persons) and in chronic tests on animals -- 30 dogs and 400 white rats. Gastric, pancreatic and intestinal juice were obtained by means of operations from dogs. The animals were kept under observation and used for experiments for about two years.

The bactericidal function of the cutaneous covering was determined on the basis of its relationship to the intestinal bacilli by the method of agar

prints. The content of lysozyme was determined by biological means, series transplantation, and the method of diffusion in agar gel. The radial acceleration that acted on the dogs were equal to 7 g for one minute, 8 g for three minutes and were in a transverse direction (chest-back). Experiments in barochambers under conditions of increased concentrations of CO_2 (7.5-14.7 mm hg), reduced barometric pressure (308 mm hg) were performed for 30-62 days. Prolonged hypokinesia was produced by keeping the subjects in a horizontal position for seven days. A new diurnal cycle (18 hours instead of 24) was used in a special chamber for 15 days.

The material which was obtained indicates a disruption of the homostatic functions of the organism under the influence of space flight factors. Under normal conditions, the level of the lysozymic activity of the sputum of healthy individuals depends on the time of the year: in summer (June-July) it is three to five times less than in the autumn and winter (November-December).

In the case of intact dogs, the secretions of the various digestive glands have different lysozymic activity and can be arranged in the following decreasing order: gastric juice (titer -- 1:765) -- saliva from the parotid glands (titer -- 1:340) -- intestinal juice (titer -- 1:227) -- pancreatic juice (titer -- 1:125). /97

A single action of radial transversely directed acceleration, real for space flight, is accompanied by an inhibition of the lysozymic activity of the gastric, pancreatic and intestinal juices. The period of after effect is long -- up to two months. Preliminary repeated influence of acceleration at low values (2 g for three minutes) was not accompanied by pronounced or prolonged inhibition of lysozymic activity of the intestinal juice. This should be taken into account when carrying out training programs on a centrifuge. A prolonged stay in the barochamber, conditions of hypokinesia and 15 days of exposure to the effects of an altered schedule cause a decrease in the bactericidal activity of the skin, the lysozymic activity of the saliva and gastric juice of the subjects.

V. A. Kozlov, P. P. Saksonov, N. N. Dobrov, V. V. Antipov and V. S. Parshin

Change in Resistance of the Animal Organism Under the Influence of Vibration to the effect of Certain Chemical Preparations and Physical Stress [59]

The tests were performed on 449 white mice. The following were used: a 70 Hz vibration, with an amplitude of 0.4 mm, for one hour, vibrational overstress, 10 units. Chloral hydrate (400 mg/kg) was injected into the abdominal cavity, and sometimes strychnine nitrate was given (1.5 mg/kg).

The toxic effect of the substances increased slightly with vibration (statistically insignificant). Injection of cystamine reduced the ability of the organism to withstand physical stress, but to a much lesser degree than in combination with vibration (the difference was statistically reliable). /98

G. S. Koroza

Change in Sensitivity of the Heart to Cardiac Glucosides in Radiation Disease [60]

The author studied the effect of strophanthin, digitalis, Convallaria, and Adonis. He noted an increase in the sensitivity of the heart to these preparations after two weeks, at the height of development of radiation disease, connected with signs of myocarditis, which as we know develops in the course of radiation disease.

V. A. Kotsyurba

Use of Radioactive Irradiation For Sterilization of Pharmaceutical Preparations [61]

Radiation sterilization of many forms of its products is of considerable practical interest to the pharmaceutical industry. Alpha-rays, which have a greater penetrating ability than gamma-rays and beta-rays, are used for sterilization.

Since the effect of radiation on a substance has to do with chemical changes which may take place during radiation sterilization, it is necessary to know their magnitude and nature.

During the action of all types of radiation on chemical substances, a number of complex processes occur in the latter whose magnitude depends on the dose of the absorbed radiation, or the nature of the substance, the energy /99
of the particles, the temperature, and so on.

A low absolute percentage of disruption of pure substance may turn out to be high relative to the disruption of the pharmaceutical preparation at low concentrations. Substances with a high reaction potential in such concentrations may turn out to be partly or completely destroyed.

However, wherever the product of radiation decay of a substance remains less than the equivalent output of radical products from the radiolysis of water, the sterilizing doses of radiation do not cause any significant changes in it even at low concentrations. A decrease in the yield of radiolysis products can be achieved in various ways -- by reducing the temperature of the irradiated preparation, increasing the intensity of the radiation dose, decreasing the integral dose of radiation, and so on. In addition, the percentage of destruction of the preparation during irradiation may be reduced by introducing appropriate acceptors of the radical products of the water or the material, suppressing the output.

A correct combination of factors that influence the decrease in the radiation yield of decay may obviously ensure effectiveness of the radiation sterilization of the majority of preparations for which they are intended.

T. N. Krupina, N. N. Gurovskiy, G. P. Mikhaylovskiy

Problems Involved in Selecting Cosmonaut Researchers [62]

In the selection process, in addition to determining evident and latent pathology, it is necessary to evaluate the functional capacities of the organism. The specifics of the medical selection of cosmonaut investigators /100
involve their age characteristics, as well as various differences in the state of health or a low level of physical preparation. The selection of cosmonauts is divided into several stages: a preliminary section at the polyclinic, selection during examination at the sanitarium, selection during the training process, and the final stage of selection -- admission to a flight.

The principal problem in the first stage involves finding those persons who have definite counter indicators for flight. A stationary examination must provide for a very careful complex examination of the organism in order to reveal latent pathology. An important aspect of selecting candidates is the psychological test. In both the selection process and in the period of initial training, it is necessary to maintain sanitation and a wide range of medical and hygienic measures. All during the preparation process, there must be systematic and continuous medical observation which is really the next stage of selection, "selection during the preparation process". The methods of selection and preparation of cosmonauts must be improved and refined depending on the characteristics of the flight, its duration, and also in conjunction with the achievements of general medicine and biology.

T. N. Krubina, O. P. Kozerenko, V. I. Myasnikov and F. N. Uskov

The Problem of Situational Insomnia During Space Flight [63]

The results of simulation experiments and brief flights indicate the possibility of development of disturbance of sleep during long voyages. /101

The situational reaction of an individual (as far as sleep is concerned), depending on the emotional significance of the disturbing factor, may turn into a "psychomotor disturbance with persistant apparent discomfort" or a state which is reminiscent of somnambulic akinesia according to Marinescu. The development of the asthenic state may lead to dyssomnic disturbances of the "nervous sleep" type according to Epshteyn.

Other disturbances of the function of sleep are possible: varying according to stress, stimulation and the arbitrary insomnia associated with it. Superimposition of asthenization on a constant overstress of excitement may cause depressive or anxiety states.

The range of disturbances runs from extreme somnolance (agrypnea) to disturbances of sleep which are related to the nature of the dreams which are experienced (some dreams are the cause of insomnia).

It is possible to have development of psychotic insomnia, of the type that is caused by catathymia (in the case of hysterical reactions) or a syndrome of ahypnognosia (pseudoinsomnia), which arises against a background of depressive, depressive-hypochondriac states, or as the result of abuse of neuroleptic preparations.

For the prevention and treatment of situational insomnia, the authors recommend a number of pharmacological substances (substances for "metabolic reanimation", a combination of stimulants of the nervous system and somnifacient substances, etc.)

The problem of pharmacotherapy requires further intensive studies.

T. N. Krupina, G. P. Mikhaylovskiy et al. /102

Pharmacological Disturbances of Changes in the Water-Salt and Protein Metabolism During an Experiment Involving Hypodynamia for 120 Days [64]

In experiments designed to study the influence produced on man by hypodynamia as well as the experience obtained as the result of space flights, changes were observed in the water-salt and protein metabolism. The purpose of this study was an attempt to isolate or prevent the changes produced by hypodynamia by means of medicinal preparation.

The experiment involved 10 healthy men aged 22 to 45, who were divided into three groups:

I - the control group, consisting of four persons;
II and III - experimental groups, three men each.

The arrest of changes in the water-salt metabolism in the second group was achieved by injecting five doses of pituitrin, daily for the last 40 days of the experiment and the intramuscular injection of 1 ml of desoxycorticosterone acetate during the period from 72 to 90 days of the experiment. Arrest of changes in protein metabolism was achieved in the third group by injecting 5 ml of nerabol during the period from the first to 28th days and 10 ml of nerabol from the 72 to 100 days.

The results showed that during the first half of the experiment, the water metabolism of the subjects in all three groups was negative, (i.e., the water excretion exceeded the utilization). Beginning with the 60-70 days, there was a tendency towards stabilization, but at a somewhat reduced level.

The excretion of potassium and sodium during the experiment changed insignificantly. Excretion of calcium increased by one and one-half to two times.

During the second half of the experiment, there were no significant changes in the protein metabolism in comparison to the data for the first half. The medicines used, pituitrin and DOKSA (deoxycorticosterone acetate) were not able to prevent changes in the water-salt metabolism caused by hypodynamia; at the same time, the use of nerabol produced positive results. On the basis of the changes in protein metabolism, the anabolic effect of nerabol appeared on the 34-36 days and remained constant for 104 to 106 days. /103

The experiments showed that certain disturbances caused by hypodynamia may be corrected by means of medicinal preparation.

T. N. Krupina and A. Ya. Tizul

Significance of Prolonged Clinostatic Hypodynamia in a Clinic Specializing in Nervous Ailments [65]

We know that the motor activity is a necessary biological requirement of man. Modern conditions under which human beings live are characterized by limitation of motor activity, so that a study of the influence of hypodynamia on many neuro-vegetative functions of the organism acquires a timely nature from the standpoint of explaining the pathogenesis of problems which develop as well as the possibility of devising preventive measures.

The problem of hypodynamia is of great practical and theoretical significance from the standpoint of the use of the latter as an approximate model of "weightlessness", studying the hypodynamic disturbances as possibly professionally harmful factors that acquire particular significance under the conditions of modern technology. In addition, clinicists in various

disciplines must take into account the negative influence of hypodynamia on the organism when committing patients to prolonged bed rest. /104

The authors studied the nature and the trend of the changes in the nervous system and especially its vegetative functions in 62-day clinostatic hypodynamia in six somatically and neurologically healthy men aged 23-36 under conditions of ground simulation. The article describes a method of investigating the functional state of the vegetative section of the nervous system by means of tests, the conditions of testing.

The subjects were divided into two groups of three men each. The subjects in the first group were subjected to a physical load of a specified intensity without disturbance of their horizontal position. The subjects in the second group did not receive any physical stress.

The first clear changes in the vegetative-vascular reflexes were noticed by approximately the third week (18-20 days of the experiment), when the subjects from the second group began to show changes in the parameters of the vegetative reflexes slightly earlier than the individuals in the first group.

Since the analysis of the dynamics of the Ashner reflex during the entire experiment indicates that the scatter of the numerical data differed by groups, somewhat greater in the subjects who had not been exposed to physical exercise.

The dynamics of the skin-vascular vegetative reflexes also differed from one group to another. The dynamics of the level of arterial pressure, which showed a tendency toward a decrease, as well as the pulse frequency (tendency toward slowing down) coincided more or less with the changes in the vegetative-vascular reflexes, that was also most pronounced in subjects who had not been subjected to physical stress.

A study of the dynamics of the sugar content in the blood and the nature of the sugar curve revealed significant (within the limits of physiological) oscillations in the indices on various days of the tests. The coefficient of hyperglycemia changed, sometimes rising, sometimes falling. The sodium content /105

in the blood serum reached a maximum at 40-50 days, increasing with the length of time spent by the subjects in bed; the calcium concentration did not exceed the limits of ordinary diurnal variations.

As the length of the experiment increased, asthenization phenomana developed and increased, and a decline in muscle tone was observed.

The EEG, recorded from 14 points on the cerebral cortex, showed an increase in the excitability of the cortex with retention of its reactivity during the first days of the experiment, a progressive decline in excitability and reactivity of the cortex and a slowing down of the cortical rhythm during the period of development of the vegetative-vascular dysfunction and the signs of asthenization.

Disappearance of the majority of difficulties took place at various times. Most of this happened toward the end of the second decade, but took place somewhat earlier among the subjects in the first group. The phenomena of asthenization, muscular hypotomia and hypotrophy remain much longer. An analysis of the nature of the changes in the various neuro-vegetative functions of the organism during a 62-day clinical hypokinesia indicates that a majority of disturbances that were observed are the consequence of certain functional-dynamic changes that take place at various levels of the CNS. The development of these changes, from the standpoint of the authors, is caused by a change in the level and the nature of the proprio-interoreceptive and sensory afferentation, taking place due to prolonged hypodynamia. All of these changes lead to a disruption /106
of the neuro-reflex mechanisms that regulate the activity of the vegetative-vascular system.

To prevent hypodynamic disturbances, it is apparently necessary to recommend together with physical exercise, other preventive measures.

T.N. Krupina, A.Ya. Tizul, N.M. Boglevskaya, V.P. Baranov, E.M. Mantsev, Ye. A. Chertovskikh

Change in the Function of the Nervous System and Several Analyzers Under The Complex Influence of Hypokinesia and Radial Acceleration [66]

To determine the nature of the direction of the functional changes that occur due to prolonged hypokinesia and its effect on subsequent ability to

withstand overloads, an experiment lasting two months was performed whose purpose was to clarify the nature and direction of the functional changes. The test involved men aged from 23 to 36. Hypokinesia was achieved by observing a strict bed rest. Three of the subjects (group A) performed physical exercises on a bicycle ergometer and with a rubber expander without disturbing their horizontal position. The other three (group B) did not do any physical exercise.

Prior to the experiment, the subjects were subjected to the action of transverse overloads at intervals of 4-6 days on two occasions, with the force being directed in the "chest-back" direction and the slope of the increase in acceleration being 0.15-0.2 grams/second. Following rotation to acquaint the /107
subjects with the process, the overload was increased to the maximum that could be tolerated. Neurological and encephalographic studies were performed for the experiment (background), on the first day of the experiment and then once every ten days; the vestibular tests were performed before and after the experiment. The function of the auditory analyzer was investigated over the entire duration of the experiment at intervals of 4-6 days.

During the recovery period from hypokinesia, all of the tests were repeated (at intervals of 10-14 days) until function was normal.

These tests showed that 62 days of hypokinesia in conjunction with relative isolation and the action of radial acceleration causes a number of transitory neuro-vegetative disturbances in the organism. The most pronounced and early of these are the vegetative-vascular disturbances and the phenomena of asthenization which develop and disappear later in the subjects who do not receive any physical stress. Functional changes in the auditory analyzer were also observed. The variations in the threshold of hearing at high frequencies were pronounced to the same degree both in the group with physical stress and in the group without it. There was a decrease in the vestibular-vegetative ability to withstand Coriolis and linear accelerations that was more clearly pronounced in the group of subjects without physical stress. The development of functional changes involving the nervous system and certain analyzers during prolonged hypokinesia is explained by the hemodynamic changes and the disturbance of the reflex mechanisms of the efferent-efferent [sic] connections.

O. N. Kuznetsov /108

The Clinic and the Phenomenology of the Behavior of a Healthy Individual During Prolonged Isolated Anechoic Chamber Tests [67]

The only activity related to the prolonged continuous stay in an ecologically closed system, applicable to cosmonautics, is also characteristic of a number of other operational processes.

The responsibility for this activity calls for definite principles of neuro-psychiatric expertise, reflecting preestablished nosological forms and their differential diagnosis with a variation from the "norm" which is specific for these conditions.

The apparent conflict of an absence of psychiatrically significant states in anechoic chamber tests simulating ecologically closed systems with an abundance of psychiatric phenomena described in strict sensory deprivation, together with the indicated shortcomings and nonexploitation of this field of experimental psychoneurology, have determined the principal trend and problems of current investigation as branches in the establishment of the principles of neuro-psychiatric expertise of operators of ecologically closed systems. The following were critical factors in the solution of the problems posed:

1) isolation and description of unusual psychic conditions characteristic of a healthy individual in a state of experimental isolation;

2) study of their cause and result relationships, performance of differential diagnosis with phenomena familiar from psychiatry in the clinical sense and a comparison of classifications; /109

3) study of individual-psychological forerunners of these unusual psychic states and the basis for their expert significance.

To solve these problems, it was necessary to study the general and individual-typological features of behavior and activity during long isolated anechoic chamber tests which served as a background on which unusual psychic states could develop.

In describing the method, the author points out that a total of 48 experiments were performed (43 men and 5 women), lasting 10-11 days. The individuals

possessed high school and college educations, ranged in ages from 21-43, and were pronounced healthy after a careful clinical examination. The study was performed in an anechoic chamber with isolation of the subject from external sources of light and sound.

Out of the 48 experiments, clearly marked unusual psychic states in various combinations were observed in 12 individuals. In the dissertation, each form is described in clinical phenomenological detail and subjected to psychiatric and psycho-physiological analysis with the aid of the required data from the literature.

The analysis of phenomenology, psycho-physiological structure and origin of unusual psychic states in individual anechoic chamber tests allows us to have some idea of the limits of the psychopathological nosological forms that can be expected when an individual is isolated in an ecologically closed system.

These forms, whose development is possible under conditions of severe exo- and endogenic conditions and which require differentiation of unusual psychic states, will resemble in their appearance and course reactive hallucinoses, paranoid and depressive states with a single conclusion, or to "paranoid behavior of external situation". /110

How this traumatizing effect of the situation of isolation in an ecologically closed system becomes natural for an exogenic-situational type of psychosis is insignificant. However, when the psychic predisposition for the reaction changes, this conditionally pathogenic situation may play a role as an existing pathogenic factor until the psychosis is established.

Measures for preventing and combatting unusual psychic states involve self examination, self control, active suppression of unusual psychic states in the initial stage, rational planning of activity and creativeness. One of the important conditions was the preparation of the subjects for the experiment. Preparation dependent on experience and knowledge of the subjects, adequacy of the system of personal relationships that had developed.

Phenomenologically, four types of tactics for behavior of the subjects with regard to gathering information about the future tests were observed during the period of direct preparation for the experiment.

The paper presents a classification of unusual psychic states during prolonged isolated anechoic chamber tests.

The author reached the following conclusions:

1) Phenomenologically speaking, the behavior of healthy subjects in prolonged isolation tests was marked by regularity of the following "behavioral /111
reactions" of orientation under new living conditions, initial, middle and final periods of pronounced emotional-adaptational stress and reactions to the observation of the experimenter (the factor of "publicity of isolation").

2) The behavior of the subject in prolonged isolation anechoic chamber tests, for the first time in clinical-phenomenological practice, revealed the following types and forms of unusual psychic states which were studied: changes in perception (eidetic impressions, illusions of recognition, subjectively realized dreams, hypnogogic musical illusions, interpretational phenomena, ideas of relationship, supervaluable ideas, errors, judgements, pettoclaustrophobia), changes in self-recognition (exteriorization reactions, feeling that another person is beside them), emotional reactions (reactions to the absence of feedback, post isolation hypomaniacal syndrome, phenomenon of "catathymic negativism") and spontaneous brief interruption of operational activity.

3) All of these forms of unusual psychic states, viewed as models, form the basis for prediction and prevention of psychic phenomena and ailments that could develop in ecologically closed systems.

4) The majority of unusual psychic states which were observed are directly related to the activity involved in active adaptation to a complex of psychophysiological conditions existing in the anechoic chamber tests.

5) The models which have been phenomenologically defined in long isolated anechoic chamber tests reflect varieties of behavior by healthy individuals, /112
involving adaptation to conditions of responsible operator activity in ecologically closed systems. The models reveal the deep foundations of the

adaptational-accommodation mechanisms in man, which are revealed when he encounters a medium which is essentially new from the psychological standpoint and conditionally pathogenic. For these conditions of existence, the states which have been defined are manifestations of the "norm" which border on the psychopathological.

6) These "prepathological" phenomena, which lie at the borders of the norm must be differentiated from psychopathology, taking into account the location and the significance of concrete and unusual psychic states in the general picture of adaptation of man and the special characteristics of these states.

7) The subjects struggle actively against the development of unusual psychic states and work out individual preventive methods (self-evaluation, self-control, suppression of their own unusual feelings, creativeness).

8) As they gain experience, operators in ecologically closed systems, in addition to their neuro-psychic stability with respect to prolonged isolation, reflecting functional capacities of the nervous system, must also take into account their "psychological preparation for work under these conditions".

9) Long isolated anechoic chamber tests make it possible to study in depth and detail individual psychological characteristics of the personality of the subjects.

10) Unusual psychic states and relatively low accommodation in experiments /113
were observed primarily in subjects who did not have any experience in life which reflected accommodation to change conditions of existence, persons who were egocentric, insufficiently interiorized, reflected a weak type of nervous activity, imbalance of the fundamental nerve processes and signal systems of activity.

11) The social-psychological structures of the individual and group isolation differed due to the dominant difficulties and personalities of the groups of subjects. While in the case of individual isolation a specific difficulty was the need to devise one's own course of behavior in the experiment, in the case of group isolation the principal difficulties lay in the

psychological compatibility and the reactions of the individual personalities to a large degree reflect the integrative nature of a concrete group.

12) Long isolated anechoic chamber tests may be used either for testing candidates for operators in ecologically closed systems or for their preliminary preparation.

O. N. Kuznetsov, V. I. Lebedev

The Problem of the Pseudopsychopathology Under Conditions of Isolation With Sensory Deprivation [68]

Articles by many foreign authors describe various psychopathological phenomena in subjects under conditions of strict and relative isolation lasting for various periods of time. In many of the experiments, goal-directed /114
activity and motor activity were completely excluded. In these experiments, using practically healthy individuals, psychopathological symptoms developed in the form of hallucinations, depersonalization and various forms of disturbed behavior. The possibility of development of such symptoms in healthy individuals attracted the attention of Soviet investigators in preparing for the first space flight.

This paper presents a method of investigation using an anechoic chamber which provides conditions of sound and light isolation, and the behavior of the subject is described.

Observations indicate that in the case of stimuli which are insufficient for reliable perception, correct perception leads to mobilization of appropriate concepts which makes possible correct recognition. Incorrect perception leads to erroneous concepts and leads to deception of the senses and an illusion of recognition. Erroneous recognition may not lead to illusions, but may appear as one of the more probable hypotheses for explanation of inexplicable stimuli to the subject.

Another subject developed the feeling that there was another person in the room. His erroneous perception was not based on visual and auditory sensations. He was firmly convinced that there was nobody in the room besides himself, but nevertheless he could not get away from this unsensed and unusual

personality. Logically speaking, he was unable to explain the reason for the development of this particular state.

The authors explain this by an aggravation of the sensitivity of the skin to a change in pressure and temperature of the air under conditions of prolonged /115
isolation.

A current of air passing over the subject's chair acts as a source of sensations that would provide material for development of a feeling of the presence of another person in the room. Insignificant changes in pressure and air temperature, which were not noticed before, became perceptible when sensitivity was made more acute under conditions of sensory deprivation, but they were recognized incorrectly as the sensation of another person.

Under conditions of isolation, the probability of confusing dreams with real events also increases. Dreams under conditions of prolonged isolation, taken as real, might be attributed with insufficient analysis to hypnogogic hallucinations, the basis of which (according to the teachings of I. P. Pavlov), are the phase states in the cerebral cortex.

In the authors' opinion, the ideas of relationship under conditions of prolonged isolation are caused by a limitation of information regarding the outside world and the egocentric relationship to one's own personality under the conditions of the experiment. This also creates an impression of one's own personality under the conditions of the experiment, as the sole object of interest of the maintenance personnel.

The grounds for the development of ideas of superiority is the conditions of isolation that determine a limited circle of interests. In the absence of one's own plan of behavior (activity), random insignificant events may acquire unjustifiably high significance in individual persons, dominating and suppressing useful activity. Ideas of superior importance, which appear during prolonged isolation, differ from pathological ideas by the fact that they develop under conditions of relative inactivity and disappear with a transition to ordinary working conditions. /116

The psychic changes which take place, in the opinion of the authors, are not pathological but individual specific reactions to conditions of prolonged

isolation with sensory deprivation. To differentiate between these specific reactions and pathological ones, the authors suggest they be called pseudopsychopathological.

Thrust into conditions of change afferentation with a practical absence of information regarding the outside world, the individual is forced to adjust his system of relationships to the outside world and adapt a completely new one which differs sharply from the ordinary.

In handling problems of pseudopsychopathology, it is necessary to study the individual psychological characteristics of the personality, which are predisposing to the development of specific pseudopsychopatholgical syndromes.

O. N. Kuznetsov, V. I. Lebedev

Postisolation Hypomaniacal Syndrome During Long Tests in An Anechoic Chamber [69]

According to the authors' observations, following prolonged tests in an anechoic chamber, the majority of subjects develop a state which in terms of its clinical picture is reminescent of a hypomaniacal syndrome.

We know that in the professional activity of pilots, cosmonauts, skydivers, sailors, etc., a new situation may very frequently arise after one stressful one has been overcome. The development of a hypomaniacal state in healthy individuals -- representatives of these professions -- after overcoming one /117
stressful situation may bring with it a lack of real danger, overestimation of one's powers and lead to hasty and premature action.

In this article, the authors set themselves the goal of examining the origin and clinical characteristics of hypomaniacal states in subjects following prolonged isolation. After emerging from the anechoic chamber, the experiment was theoretically not over for the subjects. For two days, they had to go through different tests including experimental psychological ones which would have results in which they themselves would be interested.

In the majority of subjects, following the end of isolation, there was an increased motor activity accompanied by lithly mimicry and pantomime. The vocal activity in some cases reached a state of logorrhea. The subjects during

this period were characterized by considerable impressibility. In many cases, there was a "jumping around" of the attention. Examples are provided in the article by way of illustration.

The psychic state in subjects following an experiment in an anechoic chamber, taking the form of increased motor and speech activity, slight euphoria and other symptoms, differed sharply from the state (behavior) of these persons under ordinary conditions, but the degree, nature and severity of individual symptoms differed in each one. These states following anechoic chamber tests were considered by the authors to be a hypomaniacal syndrome. The absence of a description of this syndrome in the available literature on sensory isolation, in all probability, is explained by the fact that hypo- /118
maniacal states are more difficult to diagnose due to the absence of complaints and "apparent" "adequacy" of this state following the end of the experiment. A definite recognition of this symptom complex in the experiments was possible only because we worked with the data from the observations for a long time, checking the behavior of the subjects under ordinary conditions as well as their reactions under various stress situations. It is interesting to make a comparative analysis of the errors before and after the tests were performed.

When a hypomaniacal state develops during the post-isolation period, one can clearly recognize psychophysiological mechanisms that are typical of the emotions involved in permission. Conditions of prolonged anechoic chamber tests require that the individual place considerable and continuous stress on the processes of internal inhibition. This is determined not only by factors of his own sensory deprivation, but also by the accompanying experimental conditions, for example, the factor of the publicity of his isolation. By the latter, we mean the condition of the subject who is alone but knows that he is constantly being observed. This has an important influence on the behavior of subjects, now stimulating, now inhibiting the external activity of the personality, depending on the individual personalities. Post-isolation hypomaniacal states can not be completely explained by a cyclic nature of the neuro-psychic stress and emotions involved in solution. If the euphoric state which follows a parachute jump lasts from several minutes to several hours, we

can see that the hypomaniacal state that follows isolation, as we have already /119
seen in many cases, can last up to several days.

A matter of great importance in the development of this state in the subjects is the sudden increase in information which is received during this period of the experiment. The transition from the working conditions with insufficient information to a sufficient amount and even excess information is experienced as a considerable facilitation of activity and may even cause emotional uplift. The origin of hypomaniacal states may be viewed from the standpoint of a change in the state of excitation and inhabition in the riticular and hypothalamic system.

A further study of the post-isolation hypomaniacal syndrome will make it possible to devise a system of preventive measures that will be directed at preventing the development of these states during the professional activity in overcoming stressful situations, which a model is the anechoic tests, and will also provide a basis for developing experience for physicians in treating it.

O. N. Kuznetsov and V. I. Lebedev

Exteriorization Reactions Under Conditions of Prolonged Isolation And Their Significance For an Understanding of the Mechanisms Involved in Schizophrenia [70]

At the present time, considerable material has been accumulated in the field of experimental isolation with sensory deprivation. A majority of authors who have studied this problem are behaviorists, and they have dealt with it in the sense of psychophysiological reactions of man to altered con- /120
ditions of existence (reactions to the absence of stimuli).

Others treat the reactions obtained in these experiments, on the basis of complex interaction of alarm, apprehension, situational structure and directed reduction of stimuli, striking the sense organs.

However, as K. Marx showed, the human personality bears the essence of generalized relationships. He wrote as follows: "The individual is the generalized being. Therefore, every event in his life, even if it does not

occur in direct form of a collective event (i.e., performed jointly with others), is an event and a confirmation of generalized life". (K. Marx and F. Engels. From early sources, page 590).

The purpose of the article consists in using actual material to uncover the social-psychological aspects of anechoic chamber tests under conditions of prolonged isolation with sensory deprivation, analyzing the functions of intercourse among the subjects and various ways in which they reflect the experimental conditions. The studies were performed in an anechoic chamber which provided sound and light isolation. During the experiment, the subjects were given a set program of activity, which had to be completed at the rate of four hours of work per day. During the rest of the time, the subjects were left to themselves. They were subject to continuous observation during the tests. In the course of the anechoic chamber tests, two groups of social interactions were observed among the subjects. The first was the relationships to the experimenter and the second was the relationships to themselves.

The relationships to the experimenter took the form of the phenomenon of /121
public isolation. This is the state of the subject who is in isolation but knows that he is under continuous observation. According to the authors' data, this state has an important effect on the behavior of the subjects, depending on their individual nature, sometimes stimulating and sometimes inhibiting the external signs of activity of the personality.

The relationships with themselves took the form of a complex of methods of autoregulation of behavior during the experiment and were expressed in a number of distinct phenomena. These phenomena were most clearly and fully expressed in spontaneous speech activity (monologues, taking the form of narration and dialogue).

For the sake of illustration, the article presents examples of the dialogue speech, excerps from a diary, in their entirety.

Under conditions of isolation, many of the subjects took turns first speaking as themselves and then as another person, carrying on the functions of a dialogue, but one that involved themselves alone.

The dialogue type speech is considered an exteriorization reaction, expressing the exteriorization trend of the personality.

Special social-psychological conditions of existence of an individual in an ecologically closed system require such flexibility of personal relationships on his part as would be required of him if he were in isolation and not only had to survive and carry out individual operations but also had to retain socially valuable set forms of activity and behavior.

Under conditions of ordinary interaction with people around him, an individual may carry out rather complex activity completely productively and /122
effectively, borrowing and supplementing his insufficient functions with the aid of the persons around him (work under a director, commanding and directing activity, etc.) and therefore he may be sufficiently well balanced with the surrounding social medium (in terms of exteriorization and interiorization) under these conditions. However, when he is thrust into conditions that require independent activity, this balance is upset in some persons; various forms of disturbance of this balance develop, which have a social-psychological nature. Long anechoic chamber tests under conditions of isolation were the first to clearly demonstrate experimentally the interiorization-exteriorization balance of the composite personality, making it the object both of qualitative as well as quantitative study, which is of great professional and diagnostic value.

O. N. Kuznetsov and V. I. Lebedev

Unusual Psychic States, Their Significance and Philosophical Interpretation [71]

An individual may be subjected to conditions of existence which differ from the usual ones under which he lives. The influence of many of the new factors of the medium frequently is harmful. The means of protection against the harmful effects of space and other factors are specialized objects: bathyspheres, spacecraft, etc. A characteristic of life for man in these devices is the following: a reduction of the flow of stimuli acting on the sense organs and a change in the modality of information (condition of /123

isolation). As experiment has shown, under these conditions various defections of the senses can occur. In scientific studies of sensory deprivation (sensory and informational starvation), two basically different approaches have been used.

Soviet experimenters used a special program of activity. They noticed that in the case of healthy individuals under conditions of sensory isolation, hallucinations and other psychopathological symptoms developed. Under these conditions, the necessity for orientation of the personality is most important.

An analysis of unusual psychic states under special conditions of existence must be based on specially developed criteria for the norm and pathology for these conditions.

Under conditions of isolation, it is possible to have development of the following nosological forms of pathology in individuals with a low neuropsychic resistance or other burdensome condition: reactive-isolation hallucinosis, reaction-isolation paranoia, reaction-isolation depression.

A. V. Lozovskaya

Influence of X-Rays on the Reactivity of Animals to the Injection of Strophanthin [72]

Studies performed on white mice revealed a decrease in reactivity with respect to strophanthin during the period of radiation disease which is considered may be possibly linked with a change in the functional state of the CNS, directed toward a predominance of the inhibition process. /124

V. B. Malkin

Characteristics of the Course of Acute Oxygen Starvation in Animals in a State of Anesthesia [73]

An increase in resistance to acute oxygen starvation was observed following the injection of morphine, caused by the development of protective inhibition in the CNS. After injection of ether and chloral hydrate during the development of deep anesthesia, sensitivity to oxygen starvation was found to

be reduced. Injection of hexenal was followed by a significant rise in the sensitivity of the respiratory center to hypoxemia.

Yu. D. Malyarenko and Yu. D. Tselishchev

Methods of Reducing Cases of Acute Appendicitis Among Submariners on a Voyage [75]

To reduce the frequency of development of acute appendicitis at sea, it is necessary to examine systematically the submarine crew while they are at the base in order to detect those afflicted with chronic appendicitis and those suffering from some gastro-intestinal ailments which could promote the development of acute appendicitis.

The tactics employed by doctors aboard submarines depend on concrete conditions under which they work. The majority of doctors aboard submarines /125
advocate active surgical intervention in the case of chronic appendicitis.

Thanks to the careful observation and constant medical care, as well as immediate surgical intervention in the case of patients with chronic appendicitis, there has not been a single case in which appendicitis developed among the crew of a submarine at sea since August 1963. This indicates that it is possible to effect a definite decrease in cases of acute appendicitis while at sea.

I. A. Maslov

Psychic State During Prolonged Hypokinesia [76]

The author observed six healthy men ranging in age from 23-36 who were confined to bed under ordinary hospital conditions for 62 days. They were allowed to turn over in bed without disturbing their horizontal posture. Three of them performed a special group of physical exercises each day while in a lying posture.

All of the subjects showed some form of psychic change, characterized by the following four stages:

Stage 1 (1-2 days): this state of the subject was characterized by an increased disturbance, active attempts to relate to their surroundings, and some of them exhibited "sensitivity to disturbance" with a slight tinge of fear and uncertainty ("starting state"). /126

Stage 2 (3-6 days): period of physical discomfort.

Stage 3 (10-20 days): period of actual adaptation to the conditions of the experiment. Unpleasant physical sensations disappeared, and the subjects were able to lie in one position for hours at a time without feeling any need to change their position. Their psychic state was calm and peaceful.

Stage 4 (20-35 days): period of initial asthenic phenomena. The symptoms of asthenia gradually increased, and by the end of the experiment the subjects became irritable, easily upset, capricious, reacting sharply to any disturbance, which affected their interests. They themselves frequently evaluated their condition correctly, saying that everything now bothered them. Often conflicts arose with those around them and especially with the experimenters. Disturbance of sleep became more severe. The typical complaints associated with this period made their appearance.

At the end of the first half of the experiment, a neuropathologist noticed the signs of development of vegetative-vascular dysfunction. The phenomena continued to become more severe. In addition, there was a decrease in auditory sensitivity and vestibular stability.

These psychic changes were typical of all subjects, although the degree of their severity differed. Psychic changes were somewhat more noticeable among those subjects who had not carried out physical exercises, but the small size of the group and the difference in the premorbid characteristics do not allow us to draw any definite conclusions regarding the role of physical exercise.

An example is given which indicates the important role of such a psychological factor as adjustment to a given length of the experiment. /127

Immediately and during the first few days after the end of the experiment, the subjects were excited, happy, slow in their movements, showed general weakness, deterioration of ability to withstand physical stress, and a decline in the orthostatic stability.

Hence, the clinical picture that developed primarily during the second half of the experiment corresponds to a typical neurasthenic syndrome. This is experimental neurosis in the form of neurasthenia.

Hypokinesia is a complex combination of factors acting on the human organism: reduction of motor activity, disturbance of hemodynamics, reduction of afferentation from various organs and organ systems in the organism (physical factors) and a certain degree of isolation, a change in the initial vital stereotype, monotony, sameness of the surrounding conditions (psychic factors).

The absence of a direct relationship between psychic disturbances and the duration and the known dependence on the phase of the experiment, "disturbances" at a certain stage of the experiment also indicate the dominant significance of psychic, and not physical factors.

G. P. Mikhaylovskiy, N. N. Dobronravova, M. I. Kozar', M. M. Korotayev, N. I. Tsyganova, V. M. Shilov, I. Ya. Yakovleva

Change in the General Resistance of the Organism During Hypokinesia Lasting 62 Days and the Effect of Acceleration [77]

The authors studied the general resistance of the organism during 62 days of hypodynamia. 6 and 12 days prior to the start of hypokinesia, the subjects were exposed to the action of transversely directed acceleration /128 (11.9-14.5) with a rate of increase of 0.15-0.20 g/second. The subjects were under conditions of strick bed rest in a horizontal position. Three individuals performed physical exercises of increasing intensity. In the second half of the experiment, the intensity of the stress reached 80,000-90,000 kg/day. The diet was normal. Once every 10 days, the body was washed with hot water and soap. Rotation on the centrifuge was repeated on the 18th and 50th days (11.0-16.0 g). The immunobiological reactivity was established on the basis of blood properdine, the phagocytic ability of the neutrophils, the lysozymic activity of the saliva and the bactericidal function of the skin.

Clinical observations revealed an increase in infectious ailments of nonspecific etiology in the majority of subjects during the experiment (acute

catarrh of the upper respiratory pathways, rhinophryngitis, follicular angina, acute periodontitis). One to one and one-half months after the end of the experiment, the inflamatory ailments (thrombophlebitis of the veins in the shins, catarrh of the upper respiratory pathways, furunculosis) were observed in four individuals. As a rule, those organs and systems which formerly showed some deviations from normal were most vulnerable. Studies revealed that prolonged hypokinesia causes a number of important changes in the system of general and immunobiological reactivity: in the properdenic system of the blood, the phagocytic activity of the neutrolysozymic activity of the saliva and the bactericidal function of the cutaneous covering. Also characteristic was the more severe inhibition of all indicators of natural immunity in the subjects who did not carry out their physical exercises. However, the trend /129
of the changes was the same in all six individuals. It was interesting to observe the depth and stability of the changes in reactivity. After the end of the experiment, there was no reduction of the protective antibacterial function of the organism. Apparently a change in the reactivity of the organism can be used to explain the increased tendency to fall ill during the second half of the experiment and after its end. The development of changes indicate the disruption of regulatory mechanisms of nonspecific antibacterial protection, caused by the development of hypokinesia and repeated stresses. This must be taken into account in selecting and developing preventive measures. Physical exercises reduced but did not eliminate completely the important changes that take place in the immunoreactivity of the organism.

L. S. Mozzhukhin, V. I. Kuznetsov and O. K. Kumakovskaya

Influence of Radioprotective Preparations on the Functional State of the Human Organism [78]

The influence of cystamine on the functional state of the organism of more than 500 healthy subjects was investigated. It was found that the maximum tolerable dose of cystamine was 1.2 grams per dose and 0.8 grams taken every 6 hours during the course of a day and 0.6-0.8 grams with a single daily administration for a month.

Following the administration of the dose, there was a slight increase in sensitivity to motion and the action of high temperature.

N. S. Molchanov, T. N. Krupina, V. A. Balandin, A. V. Beregovkin, M. M. Korotayev, I. A. Kuklin, Ye. T. Malyshkin, V. V. Nistratov, A. S. Panfilov, V. M. Tolstov /130

Results of Clinical Examination of the Cosmonauts, A. G. Nikolayev and V. I. Sevast'yanov [79]

During all stages of the flight, the cosmonauts felt well and noticed no decrease in their working ability. While the organism was adapting to conditions of weightlessness, tilting the trunk and head caused sensations reminiscent of those produced by Coriolis forces.

Difficulty was encountered in orientation when vision was blocked and whenever they lost their grip. The period of adaptation was accompanied by a sensation of flow of blood to the head, while V. I. Sevast'yanov suffered from a blocked nose without signs of rhinitis.

Both cosmonauts felt that the most difficult period was that of readaptation to terrestrial conditions. After landing, they noticed severe sensomotor disturbances that took the form of a feeling of increased heaviness of the entire body and surrounding objects. They had the impression that overloads were constantly acting on the organism. These sensations gradually decreased and had vanished completely by the fifth day.

At the same time, static-kinetic disturbances were observed in the form of instability when standing and walking.

Immediately after landing, a speeding up of the pulse to 120 beats per minute were observed. The maximum arterial pressure increased to 140 mm, the minimum to 90-100 mm Hg. Orthostatic stability decreased sharply.

According to the data from X-ray tests, the dimensions and volume of the heart decreased slightly. /131 Both cosmonauts showed a decrease in the muscle volume of the lower extremities and a decline in the tone of the latter, as well as in the periostal and tendinous reflexes in the legs and hands, together with an inhibition of abdominal reflexes.

Examination revealed existence of a pattern of alternation in the restorative processes. By the 10th day, the majority of the functional systems had returned to normal. However, there still was some general asthenization: increased fatigue, reduced working ability, vegetative-vascular instability.

The tests which were performed indicate a need for extensive clinical-physiological study of the period of readaptation of the organism following the action of prolonged weightlessness, as well as a search for methods and means of prevention as well as treatment of readaptation difficulties.

Yu. G. Nefedov, Ye. I. Vorob'yev, I. N. Gurovskiy et al.

Some Results of Medical Monitoring During Flight and Postflight Examination of the Crew Members of the "SOYUZ-3", "SOYUZ-4" and "SOYUZ-5" Spacecraft Crews [80]

The principal tasks of the flight were:

1. Study of the reactions of the human organism and its psycho-physiological capabilities during performance of dynamic operations involved in maneuvering, rendezvous and docking.

2. A study of the reactions of the organism during a stay and during performance of work in deep space.

3. Study of the influence of weightlessness on the organism. /132

4. Study of the organism during the period following the flight.

The following were recorded during the flight:

a) pulse frequency;

b) EKG, with DS chest leads;

c) seismocardiograms;

d) pneumogram.

During the transfer from one craft to another:

a) pulse frequency;

b) body temperature.

In the preflight and postflight periods, extensive clinical examinations were performed: they included tests of the CNS, the circulatory and respiratory systems, gas-energy metabolism, water-salt exchange, etc.

During the flight, the cosmonauts felt extremely well, although Beregovoy noticed some illusions and slight disturbances of coordination at the beginning of the flight. The other cosmonauts noticed a flow of blood to the head (similar to the head-down position under terrestrial conditions). Their appetites and water drinking were not disturbed. Their sleep was normal.

Yeliseyev and Khrunov even managed to reduce their sleeping time to 4-5 hours a day. Preparation for the space walk and emergence from the spacecraft did not pose any difficulties and there were no problems at all with spatial orientation.

Working ability remained at a high level during the flight. During his space walk, Khrunov's pulse was 154, his respiration was 49; for Yeliseyev, the pulse was 134 and the respiration 36; the EKG and seismocardiogram remained at the original levels. /133

During the flight, comfortable conditions were maintained in the cabin. Changes in functional indicators were linked to neuro-emotional stresses and weightlessness.

The dose of radiation did not exceed the calculated value. Weight losses varied from 2 to 4 kg, and were made up 2-3 days after the flight. The weight loss was caused by a loss of fluid. After the flight, an increase in the hematocrit was noticed, there was no muscle atrophy and weight was rapidly regained. All of the changes lay within the limits of permissible oscillation and are usual for flights of such duration.

Candidate in Medical Sciences T. V. Nikitina

Development and Progress of Basic Stomatological Diseases Under Conditions Immitating Space Flight [81]

The paper deals with theoretical aspects regarding the causes for the development and details of the progress of the principal stomatological ailments under the influence of a number of extremal factors.

There is a detailed discussion of the problem of the disruption of mineral metabolism, especially calcium metabolism under conditions of influence of space flight factors and the conditions which develop due to the demineralization of the teeth and the bone tissue of the alveolar branches. Individuals in conditions of prolonged hypokinesia showed a significant change in the stomatological condition, taking the form of new carious bands, development of congestive phenomena in the boundary areas of the gums, a reduction of the /134
cortical layer of the lower jaw, destructive changes in the gums. When the original condition include caries and the initial stages of parodontitis, there is an intensification of the carious process and a strengthening of the dystrophic processes in the gums.

A clinical-diagnostic complex of stomatological selection of cosmonauts is proposed, including X-ray examination by means of the method of panoramic X-ray photography and orthopantomography and a series of functional tests.

To clarify the latent pathology of the gums, it is recommended to perform polarography, rheography and capillarography.

The principal counter indication for admission to a flight are felt by the author to be extensive caries, parondontitis of all types and stages, recidive ailments of the mucus membrane of the oral cavity, the existence of chronic odontogenic foci in the periapical tissues, arthritis and arthrosis of the temporo-lower mandibular substance, etc.

I. Yu. Ozolin, Z. M. Evenshteyn

Procedure to be Followed by a Ship's Doctor in Acute Appendicitis [82]

In those cases when it is not possible to evacuate patients in time, they must be treated conservatively for a short time or else an appendectomy must be performed directly aboard the submarine. In the majority of cases, active surgical intervention is justified.

When selecting methods of treating patients with appendicitis, it is /135
always necessary to remember the possibility of atypical clinical progress of the disease.

The authors feel that while submarines are at their bases or near submarine tenders, the best method of preparing the surgical staff is the practical performance of surgical operations in an operating room with subsequent transfer of the patient to the submarine tender or the base, where he can get the necessary bed rest.

A. G. Panov, V. S. Lobzin

Some Neurological Problems of Space Medicine [83]

To solve the problem of possible disruptions in the function of the nervous system in the early stages of a long space flight under conditions of ground simulation, four volunteers were selected who were absolutely healthy, somatically and neurologically; they were men aged 22. They were subjected to strict bed rest for 72 days.

An a alysis of the results of the clinical-neurological examination of the subjects showed that the changes which took place in them during prolonged hypodynamia have a definite separation into stages.

The first stage (about 10 days) is characterized by the development of early accommodation reactions in response to hypodynamia, and the development of /136 general weakness is seen. During the second, intermediate stage (also lasting about 10 days), no unpleasant sensations are felt. The third stage (after 20 days of hypokinesia) is characterized by the development of difficulties in higher nervous activity; it takes longer to fall alseep (up to 3 hours), sleep was light, dreams took on an unpleasant nature; there were frequent changes in mood during the day for no particular reason. Development of severe neurological conditions was also possible in one of the subjects, so that his experiments were terminated.

Beginning with the 22nd day of hypodynamia, there was a slight increase in the threshold of painful sensitivity. By the time the hypodynamic regime had reached its peak, the disruptions of the functions of the nervous system and the circulatory difficulties were maximum.

The ability to withstand transverse overloads during rotation on the centrifuge (after 72 days of hypodynamia) also decreased markedly (from 12.5

to 9.3 units). During the recovery period (activation of the motor regime and normalization of functions), general weakness and fatigue were observed for a long period of time, as were orthostatic diziness, a sensation of heaviness in the head, instability in the Romberg posture, aches and pains in the small of the back, etc.

Obviously the influence of dynamic factors on the nervous system during prolonged interplanetary flight may be quite significant, and the summation of their effects with that of other factors will considerably increase the probability of more severe nervous difficulties.

The solution of problems of prevention must follow both a path of technical progress (development of artificial gravitation aboard the spacecraft, protection against radiation, etc.) as well as along a path involving development of medical recommendations. /137 A consideration of the phasality in the development of disruptions of the nervous system makes it possible to a certain degree to plan in advance for certain preventive and curative measures.

After 20 days of flight, sedative and soporific substances may be required. Some of the soporifics (barbital, barbital sodium, phenobarbital) definitely cannot be used for space flight due to the excessive length of the sleep which they produce (often up to 12 hours), the existence of severe posthypnotic effects (heaviness in the head), sensations of breakdown, sleepiness, apathy, etc., as well as other phenomena (cessation and reduction of diuresis, increase in vegetative reactions, weakness, diziness, fatigue, ataxia, exanthema), while others cause sleep of normal duration and do not have any of the after effects mentioned above, but they do have a hypotensive effect and can even cause collapse (chloral hydrate, sometimes barbamil).

Such preparations as cyclobarbital, which causes sleep lasting 6-7 hours, has no posthypnotic effect and does not reduce working ability, are more appropriate for the conditions of a long space flight. Noxiron can also be used. Rapid onset of sleep (15-20 minutes after taking the medicine), deep and short sleep (2-3 hours), absence of a posthypnotic effect and other side effects are characteristics which are convenient for regulating sleep at any time of day, including immediately after sleep has been interrupted.

Neuroleptics (great tranquilizers, antipsychotic substances) are usually employed to suppress effective stress, and also as antihistaminic, antiemetic and sedative substances. However, all of them (aminazine, etaperazine, /138 stellazine, frenolon and diprazine to a lesser degree) have a pronounced adrenolytic effect and sometimes cause orthostatic collapse, so that their use on space flights is undesireable.

Ataractics (lesser tranquilizers) do not have any effect on the circulation and respiration, even in large doses. Andaxine (meprabamate, meprotane) also cannot be recommended for cosmonauts, since they have a weakening effect on the muscles. Trioxazine, however, not only does not have any side effects but also increases the working ability, reduces fatigue and has absolutely no inhibiting effects on the processes taking place in the muscles.

It is undesireable to include dimedrol in the medicine chest of a spacecraft for use as an antihistamine, since it also acts as a soporific, frequently causes diziness, headaches and dryness in the mouth. The best of the antihistamines and antianaphylactics is diazoline (its long action, lasting 2-3 days, even after a single dose, and there is a lack of [Note: word misspelled in original] effect of an influence on the activity of the cardiovascular system, in contrast to the derivatives of phenothiazine and dimedrol).

In selecting antibiotics, it is necessary to keep in mind the possibility of a toxic effect of penicillin on the nervous system ("penicillin epilepsy") and the effect of streptomycin on the vestibular apparatus.

Hypodynamia and dyscirculation are of fundamental significance in the development of disturbances of the heart and nervous activity. This makes it understandable that active physical exercise is so important, using rubber stretchers and other gymnastic equipment. Overcoming regional (especially /139 cerebral) difficulties in hemodynamics may be facilitated to a considerable degree in the struggle against gravitational collapse. Not very much has been done in this regard so far.

The most probable cause of spastic syndrome under conditions of interplanetary flight may be the impoverishment of the organism with respect to

calcium salts. Calculations based on the idea of mechanical correction of calcium deficit by means of its exogenic introduction under conditions of prolonged weightlessness are inadequate. We can speak only of attempts at finding a method of regulation (possibly, hormonal) of the disturbances of the mineral metabolism in general. Among the symptomatic antispastic substances, preference must be given to hexamidine, in view of the absence of their narcotic effect when using it.

Prevention of muscle atrophy and stimulation of the neuro-muscular periphery assumes (besides the measures indicated above) the inclusion of alpha-tocopherol in the diet of the cosmonaut as well as pantothenic acid. Attention must be given to the problem of the importance of such stimulators as proserine or oxazil.

V. V. Parin, Ye. B. Zakrzhevskiy and R. M. Bayevskiy

Clinical Aspects of Interplanetary Flights [84]

The complex action of space flight factors may cause the development of certain yet unknown pathological changes. On the other hand, ailments are possible which are linked to autoinfection, disruption of nervous or endocrine regulation or the action of unfavorable factors such as cosmic radiation. /140

Ailments in interplanetary flight may be classified into one of the following forms:

1. those caused by living conditions (hygienic medium, diet, environment, psychological factors);

2. those caused by the action of factors in interplanetary space (cosmic radiation, electromagnetic fields, weightlessness);

3. those connected with endocrine factors (autoinfection, disruption of nervous and endocrine regulation).

To solve the problem of possible ailments in space flight, it is desireable to use experience gained in marine and polar medicine, which provides statistics on morbidity among isolated groups.

A possible approach to morbidity among interplanetary crews is important in planning both the diagnostic procedures and the medical aid to be rendered. Obviously, the possibility of development of pneumonia or appendicitis on a long flight is greater than that of certain other ailments. The possibility cannot be excluded that there will be quite frequent disruptions of the coronary blood circulation.

Extensive use must be made of the concept of variable possibility of ailments, and there must be a detailed mathematical analysis using modern means of computer technology.

The existence of general characteristics in the course of "terrestrial" and "space" ailments makes it possible to study in the clinical material models of those disturbances which might arise in space. This approach to the problems /141
of space diagnosis opens up the pathway to the simulation of the effectiveness of diagnostic algorithms and their testing on Earth. This will make it possible to increase considerably the diagnostic effectiveness of future automatic systems aboard interplanetary spacecraft.

The experience gained from clinical-physiological estimates of electrocardiograms and seismocardiograms, recorded during the flights of Soviet spacecarft have shown that a comparison of data obtained by diverse methods in the clinic (mechanisms of action being known) and in flight (mechanisms of action not known) make it possible to put together a much more accurate idea about the origin of the changes that develop in space. Thus, it has been possible to confirm the existence of a definite dynamics of "intra- and extra-cardiac" mechanisms of compensation depending on the duration of the flight (R. M. Bayevskiy, Yu. N. Volkov). Clinical confirmation of data has been obtained concerning the retention of a high functional level of heart muscle under conditions of weightlessness with a definite reinforcement of the tone of the parasympathetic nervous system (R. M. Bayevskiy, Yu. N. Volkov, I. I. Zhukov). The clinical effectiveness of algorithms of automatic medical monitoring has been demonstrated; they were devised for use aboard spacecraft (Yu. N. Volkov).

Forms of medical aid aboard interplanetary spacecraft may include all necessary measures all the way to reanimation. Diagnostic possibilities for the

physician must be increased by means of automatic devices and special tables and instructions. It will be necessary to perform probability-statistical calculations to select the most rational assortment of medical aids. The /142
problem also arises of the microminiaturization of the preparations. It is necessary to automate not only the diagnosis but also the treatment.

The probability-statistical approach also requires a program of training for the interplanetary physician. The problem of preventive appendectomy, at least for the doctor of the spacecraft, arises.

Without considering the probability of morbidity of the interplanetary crew and studying the possible methods of treating them, it is impossible to plan for flights of long distance and duration.

V. V. Parin, P. V. Vasil'yev and V. Ye. Belay

The Problem of Reactivity in Space Medicine [85]

The change in reactivity of the organism by means of pharmacological substances is one of the promising methods of increasing resistance to the effect of overloads.

Under the influence of overloads, there is a change in the sensitivity of the organism to a number of pharmacological preparations: narcotics (chloral hydrate -- an increase in the duration of the narcosis by a factor of 2); cardiac glucosides (increased sensitivity to strophanthin and convaside). Vasoconstrictors (noradrenaline, adrenaline) and vasodilators (nitroglycerine, papaverine) produced more pronounced and prolonged increases or decreases in blood pressure.

V. V. Parin, V. M. Vinogradov and A. N. Razumeyev /143

Problems of Space Pharmacology [86]

At the present time, the basic principles of assembling the medicine chest for a spacecraft can be studied only within very general outlines, and it is also necessary to consider some of the trends in attempting to find preparations that are specially intended for use on long flights by man into space.

In the following, the problem will be discussed in several stages.

For the preflight period, it is recommended that the sensitivity of the individual to medication be determined, both in a state of rest and with simulation of flight factors, in order to study the effect of medications during changes in reactivity of the organism. In order to prevent infection, the question arises of the sanitary treatment, the use of antibiotics (sulfamides, antiseptics) for the purposes of freeing the organism from pathogenic flora and viruses.

During takeoff and landing, it is necessary to raise the sensitivity of the organism to overloads. For this purpose, we can use pharmacological operations:

- those which simulate various brain structures: corazole, strychnine, caffeine, phenamine. The safety of these stimulants of the nervous system is not guaranteed with changes in reactivity;

- adrenomimetics (adrenaline, noradrenaline, ephedrine, metazone, metraminol, etc.). Three preparations may be recommended for study: metazone, metraminol and mephentermine and those substances which act directly to stimulate the smooth muscle element of the vessels (hypertenzine, vasopressin, etc.).

Protection of the organism against the influence of overloads is possible /144
by using antihypoxic substances (gutimine, etc.), as well as substances which prevent an increase in pressure in the pulmonary vessels, reduce the secretion of glands and the tone of the bronchi. Mephentermine and isadrine among the vasodilatory adrenomimetics must be investigated. It is suggested that the preparations in the atropine group be tested. During the flight, it is proposed to use methods for prevention of disruption of regulation of vascular tone and their consequences, prevent hypotrophy of the heart and reduction of the functional reserve of the myocardium, caused by prolonged weightlessness and hypokinesia, methods of treating acute disturbances of heart activity and vascular tone with traumas and other causes.

Vasodilatory preparations such as nitroglycerine and isodrine are suggested for use for training the baroreceptors. The medicine cabinet should also

contain vasoconstrictors. To prevent hypotrophy of the heart, it is recommended to use preparations that are capable of activating the synthesis of contractile proteins and reparative processes in the heart (apilac, vitamin B_{12}). For treating severe and marked decompensation of heart activity, two groups of substances are recommended:

- preparations that provide the energy requirements of the heart (carbohydrates, enzymes-cocarboxylase, nicotinamide-adenine dinucleotide, cytochrome S-, vitamin B_{15} and pantothenic acid);

-cardiotonic substances: strophanthin, digoxin, heptamil.

The medicine cabinet must also contain the basic electrolytes: potassium chloride, as well as calcium, which have a cardiotropic effect.

Disturbances of metabolism that are linked to hypokinesia, such as loss of /145
calcium, atrophy and others, should be prevented by taking anabolizing steroids (dianobol, narabol, etc.), biogenic anabolizers (apilac, etc.), purinic (meradine) and pyramidinic (cytozine, orotic acid, etc.), bases and certain vitamins (B_{12}, foleic acid). The problem of sleep and wakefulness is discussed. Among the soporifics, the following are recommended: sodium oxybutyrate, hemithiamine; among the small tranquilizers, trioxazine and librium, while among the great tranquilizers, haloperidol and triphthazine are recommended.

It is suggested that dexedrine be used as a stimulant from the first group.

In the struggle against fatigue, some hope has been placed on potassium and magnesium asparginate, glutaminic acid, vitamins B_1, B_6, pangenic acid and adenosine triphosphate. Assuming that hypoxia is to blame for fatigue, the authors expect an effect from meditane. Scopolamine and dexedrine (adonine) are valuable in case of vestibular disturbances.

Radioprotective substances must be included in the medicine cabinet. The question of the medical preparations to be used in traumas and acute surgical ailments as well as substances for anesthesia and reanimation is discussed. In the event of blood loss aboard the craft, direct administration of blood and the use of blood substitutes is possible.

A system for injecting solutions under pressure is proposed. It is suggested that local anesthesia with trimecaine be used to prevent pain during operations aboard the craft, following appropriate preliminary medication (for example, using a mixture of promedol, scopolamine diprazine). Inhalation anesthesia is not recommended under these conditions while intravenous anesthesia with barbiturates is considered dangerous. /146

The authors propose a study of the method of neuroleptanalgesia: the use of a strong neuroleptic with a pronounced antishock effect (droperidol) and a very active analgesic (phentanil) which is 100 times stronger than morphine (both preparations are administered in the vein). Phentanil acts for less than an hour. Its negative effect on respiration is compensated by inhalation of oxygen, and is eliminated at the end of the operation by an injection of nalorphine. The method may be supplemented by superficial anesthesia by injecting into the vein one of the new "cortical" anesthetics (gamma-ON, hemithiamine), with the patient being put on artificial respiration. This method is much safer than the use of barbiturates and deserves study by space medicine.

L. V. Pastushenkov, and V. M. Vinogradov

Experimental Therapy and Prevention of Acute Hypoxia With the Aid of Gutimine [87]

The paper stresses the positive effect of gutimine, injected intravenously in a dose of 30-50 mg/kg of body weight during oxygen starvation of the brain in mice, rats, cats and dogs. Gutimine is also effective in the case of tissue hypoxia, caused by cyanides (100 mg/kg). It reduces the consumption of oxygen and does not reduce working ability.

R. V. Petrov and V. D. Rogozkin /147

Principles of Antibiotic Therapy in Acute Radiation Sickness [88]

Radiation has a marked inhibiting effect on immunity. In the case of animals with radiation sickness, some antibiotics (levomycetin, streptomycin), especially when combined, increase the hemorrhagic phenomena as well as

leucopenia. Antibiotics may have an unfavorable effect on the systems, even those which are not damaged by the action of ionizing radiation.

L. Ye. Ponomarev

Medical-Hygienic Care of Individuals on the Drifting Ice Station "North Pole-4" [89]

Drift 1955-1956. Dangers: breakup of the ice, loss of orientation, blizzards, night, fogs in summer, frosts in winter, changeability of the weather, night lasting five months. The principal condition involved in prevention of several ailments is correct organization of the living schedule and the working processes. Special emphasis was placed on sanitary care of the living quarters. The area of each hut was 11 m^2, in which space four men lived. The structure of the hut is described in detail, as are the caloric content of the food and the diet. No cases of avitaminosis were recorded during the last 10 years among the expeditions. Solar radiation and artificial ultraviolet light were used. The medical selection of those who would take part in the expeditions imposed very strict requirements. Particularly great /148
emphasis was placed on anamnesis, since some ailments might become more severe or recidivate under the unfavorable conditions prevailing on the ice. There were cases in which it became necessary to evacuate individuals to the continent because of gastritis or stenocardia which had become acute. All of the medication at the station were in the form of tablets and ampoules. The following materials were available for use in case of first-aid surgical assistance: 1) sterile linen and material in boxes; 2) sterile bandages, napkins and cotton in factory packs; 3) surgical instruments.

Very simple analyses of urine and blood could be performed in the laboratory. The only ailments that developed were colds of the flu type, which were easily overcome. Monthly medical examinations revealed some physiological changes: disruption of the rhythm of sleep, decrease in appetite, loss of weight, changes in arterial pressure, and the hemoglobin content in the blood. The regenerative properties of the tissues, judging by the healing of wounds, remained relatively high.

I. G. Popov, V. V. Borshchenko, F. K. Savinich, M. I. Kozar', A. M. Finogenov

Study of the Condition of the Skin in Man Under Conditions of Prolonged Limitation of its Hygienic Treatment [90]

In order to study the processes of contamination and the condition of the cutaneous covering, as well as materials to be used for indoor clothing to be worn by cosmonauts, experiments were performed lasting 23 to 60 days. Subjects were men aged 19-26 who were forced to remain in closed areas from 5 to 20 m^3 in volume. /149

A special characteristic of the experiments was the deprivation of water or other means of washing the skin covered by clothing, i.e., about 80% of the total surface of the body. The skin of the face, wrists as well as the feet in some subjects were treated periodically with cleansing substances with a water-alcohol base. The underwear, outer clothing and shoes were not changed for new ones during the experiment.

The contamination of the skin and clothing by products of the sweat and sebaceous glands was evaluated on the basis of the accumulation in them of the chlorides and organic substances.

The microflora on the surface of the skin and underwear were characterized by a predominance of saprophytes of the following types: *Staphyloccus albus*, diphtherial bacillus and *sarcina*.

The bactericidal ability of the skin was evaluated in relation to *V. Coli*. Tests performed on the skin in the vicinity of the forearm, indicated a gradual decrease in the bactericidal properties of the cutaneous covering. The index of the bactericidal property of the skin of the forearm before the experiment was 90-95 while after 30 days it was 60-70.

It was found that the subjects developed skin ailments that were rather widespread under ordinary living conditions. Osteofolliculitis was most frequent. Individual furuncules, which developed in three of the subjects, were localized on the skin of the face, neck and forearms and developed during the 2nd and 3rd weeks of the experiment. Acne vulgaris developed in those subjects who in the past had had hypersecretory conditions of the subaceous

glands of the skin. Dermatitis was observed at the points where the electrodes of the physiological and clinical apparatus were attached to the skin; /150
streptococcal intertrigo of the skin developed in the area of the perineum in one subject. Epidermophytosis of the feet developed in one subject.

In the event of limitation of extensive use of cleansing substances in flight, creation of appropriate hygienic conditions in the spacecraft quarters (sensible design), sanitary-living facilities, methods of eating, types of clothing, appropriate microclimates for heat production of the organism, etc.), it is possible to achieve a significant reduction of the contamination of the skin of the cosmonauts both by external substances and by products of the vital activity of the skin.

The supply of medicine aboard the spacecraft must be assembled with an eye toward the possibility of development and treatment suppurative diseases of the skin.

P. P. Saksonov, V. V. Antipov and B. I. Davydov

Medicine Chests for Spacecraft [91]

Special medicine chests have been installed aboard Soviet spacecraft. These chests contain radioprotective substances, stimulants for the central nervous system, analgesics and some other preparations. All of the flights that have been made thus far have taken place under favorable conditions, so that there were essentially no direct medical indications that medicine should be used. However, on longer space flights there will surely develop the need /151
for using some medicine.

It must be emphasized that the organization of the medical substances to be carried aboard a spacecraft is a very serious and responsible task. These medicine chests must include only the necessary minimum of preparations and medical instruments. Under conditions of space flight, prescription (and taking) of medicine is possible only with the strictest observation of carefully worked out medical procedures. It is categorically forbidden, for example to recommend a preparation which has a positive effect on the functions of the vestibular apparatus and at the same time reduces resistance to

penetrating radiation. For example, substances that are widely used in medical practice such as aspirin, pyramidone, and salicylates cannot be included in the medicine chest, since they sensitize the organism to ionizing radiation. Those radioprotective substances which are included in the medicine chest must be such that they do not reduce the resistance of the organism to overloads, weightlessness, and other flight factors.

It is obvious that the composition of the medicines and medical instruments in the medicine chest will be determined by the length of the flight, size and weight limitations, presence of a doctor in the crew, the number of crew members and so on. The most convenient and useful medicinal forms under space flight conditions are dragees, pills, capsules, tablets and finally injection cartridges. All other types of medicine (drops, suppositories, solutions, infusions, powders, etc.) cannot be included in the medicine chest. The packaging of these medicinal substances is also of great importance. /152
They must be portable and convenient for use under conditions of weightlessness.

It has been known for a long time that certain people have extreme or even adverse reactions to many medicinal substances. An example of this is the excitation instead of quieting down which may develop when barbiturates are taken. In most people, phenamine causes stimulation of the central nervous system, reduces fatigue, but in some people it causes inhibition and even deep sleep. A monograph by G. A. Aleksander describes in detail the various types of complications that can arise when medicinal substances are used. Hence, when assembling the medicine chests, it is necessary to keep in mind that cosmonauts should be protected against these reactions if possible. What must be done to accomplish this? In the first place, those medicinal substances which most frequently cause allergies should best be omitted from the medicine chest. Secondly, when preparing for flight, all crew members must be checked for their individual tolerance of these medicines that are to be included in the medicine chest aboard the craft, especially those which the cosmonaut is most likely to use during the flight. Thirdly, when it is necessary to take some medicine during the flight, it is most advantageous for the cosmonaut himself to conduct a biological test of ability to withstand this preparation, i.e., by taking the preparation not in its full dose, but only 1/5 or 1/4 of it,

and if no exaggerated or inverted reaction is observed after 30-45 minutes, he can take the full dose of the preparation. Fourthly, if the cosmonaut experiences an allergic reaction from taking the preparation, appropriate /15
medicine must be provided in the kit to enable him to get over these complications; the cosmonaut must know which medicines these are and how to use them correctly. Finally, it should be taken into account when assembling the medicine chests that there will be changes in the reactivity of the organism to medicines as a result of extremal flight factors acting on the organism.

P. P. Saksonov, V. V. Antipov, N. N. Dobrov, V. S. Shashkov, V. A. Kozlov, V. S. Parshin, B. I. Davydov, B. L. Razgovorov, A. S. Morozov, M. D. Nikitin

Outlines of Pharmacochemical Protection Against Radiation Damage During Space Flight [92]

The problem of finding effective pharmacochemical substances for protection against radiation damage during space flight is of extremely great scientific and practical significance. Pharmacological substances for protection must be developed primarily within the system of measures for ensuring radiation safety on space flights.

The problem of chemical protection against radiation damage under space flight conditions has been treated hardly at all experimentally.

The radioprotective preparations that are known at the present time, are the type of mercamine, mercamine disulfide, aminoethylisothiuronium, serotonin, 5-metoxytryptamine and others have a good protective effect on animals that have been exposed to X- and alpha-radiation at a comparatively high dose /154
intensity. Animals received a lethal dose in a comparatively short time (from 5 to 40 minutes). Some of the preparations (mercamine hydrochloride, mercamine salicylate, mercamine disulfide, aminoethylisothiuronium) proved to be highly effective on human beings in the clinic as well.

Under space flight conditions, all biological objects are subject to the action of many factors: ionizing radiation, acceleration, vibration, weightlessness, noise, changing barometric pressure and gas composition, etc., which may have an effect on the organism with highly diverse combinations and various sequences.

Under the difficult conditions of combined action of cosmic radiation and other flight factors, by no means all radioprotective substances which are effective under ordinary terrestrial conditions can be recommended as radioprotective substances.

Particularly rigid requirements must be imposed on the chemical preparations which are intended as individual means of protecting the crew against the injurious effect of cosmic radiation.

The problem of finding effective methods of protection against radiation damage to the crew and the entire biocomplex during space flights is not only a timely problem but one which is very complex and very little worked on thus far.

Attempts to find protective preparations must be conducted both along the lines of improving known radioprotective substances and also with eye toward synthesis of new preparations. /155

A preparation with good radioprotective properties must necessarily be subjected to experimentation under the combined action of radiation with certain flight factors which can be created under laboratory conditions (vibration, acceleration).

A preparation which is recommended as an individual radioprotective substance for the crew of a spacecraft must have a pharmacological characteristic which is as complete as possible. Without this, there can be no question of its practical utilization.

V. A. Samtsov, D. N. Lazareva, R. G. Teregulov

Effective Ionizing Radiation On Reactivity of the Animal Organism [93]

In irradiated rabbits, sensitivity to narcotics increases (phenamine, amytal sodium), adrenaline and eryside; the sensitivity to acetylcholine changes.

A. A. Semeykina

Physico-chemical and Pharmacological Analysis of Barbamyl Following the Action of a Number of Extremal Factors [94]

The medicines to be included in the special medicine chests, besides being convenient to use and reliable in their action, must retain their physico-chemical and pharmacological properties following the action of various space flight factors on them. /156

This work is devoted to a study of the retention of its effect by the active substance in barbamyl following its exposure to a number of factors (temperature + 50°C, humidity 95-98 %, increased oxygen content up to 97%, change in the gas composition of the medium -- oxygen 50%, carbon dioxide 3%, nitrogen 47%, vacuum up to 10^{-4} mm Hg, radiation of 30,000 rad, linear, vibrational and shock overloads).

The tests were performed with a number of medicines including barbamyl, with a certain order of the action of the above mentioned factors. The medicines were studied after the complete exposure to all of the above effects and partial combinations of them. The physico-chemical analysis of the barbamyl tablets was conducted using methods recommended by the State Pharmacopaea of the USSR (Nineth edition), using spectrophotometry.

As a result of the physico-chemical tests which were performed, it was found that the resistance of the barbamyl tablets to compression decreased by a factor of 2 and the solubility time increased from 10 to 40 minutes. Spectral investigation and chemical analysis revealed that the structure and contents of the active substance had not changed.

The pharmacological tests of the activity of the experimental barbamyl were performed on mice using a generally accepted method; it was found that there was a soporific effect that did not differ in its degree from that produced by control doses of barbamyl.

N. K. Simeonova /157

Change in Reactivity of the Organism Under the Influence of Radial Acceleration and the Course of Several Pathological Processes Against This Background [95].

Under the influence of radial acceleration, there was a decrease in the reactivity of the organism. Among those animals which had been subjected to transversely directed radial acceleration (30 g -- 3 minutes) the lethal effect of strychnine (1:1000, i.p. 0.015 mg/kg) was less than in the control group or developed at later stages than among the controls. When chloral hydrate was administered (300 mg/kg i.p.) to those animals which had been subjected to rotation, the length and depth of anesthesia were increased.

P. I. Syabro

Principles of Prevention and Therapy of Motion Sickness [96]

Since motion sickness is a reflex reaction, in order to prevent it pharmacological substances must be able to act on one or more aspects of the regulation of the vegetative reactions involved in motion sickness.

According to the data of various authors, the preventive effect achieved by acting on the central branches varies from 20 to 100%.

In order to obtain a more complete effect in preventing motion sickness, it is necessary to employ also the influence on the effector branch of the reflex reactions involved in motion sickness, i.e., to reduce and interrupt the conduction of impulses through the ganglia and efferent nerves, to reduce the sensitivity of the consuming organs to the centrifugal impulses. /158

Proceeding on the basis of theoretical assumptions regarding the complex action on the central and effector branches of the reflex reactions involved in motion sickness, some complex preparations were developed: platybrin, plavephine, pheplavine. They contain components which act simultaneously on the central as well as effector branches. All three preparations were found to have a pronounced antiemetic effect in the experiment without inhibiting the reflex activity of the organism (under given conditions of diet and motor-defensive reflexes, encephalography and biochemical blood components). These

preparations may prevent motion sickness in individuals during flight on aircraft and without any pronounced side effects.

In the scientific testing, only under the condition of use of the double-blind control method involving administration of indifferent substances (placebos) and a well known effective preparation against motion sickness (scopolamine, aerone) is it possible to achieve reliable comparative data on the effectiveness of various new types of procedures for prevention and treatment of motion sickness.

Yu. N. Tokarev, A. I. Pantyukhin, I. G. Rumyantsev

Prevention of Flu and Its Complications by Dibazole [97]

During the flu epidemic of 1959, the preventive effect of dibazole on the contraction of flue was tested, as well as its influence on the course of the disease and its complication. For this purpose, 2,000 individuals received dibazole powder for 15 days. Dibazole was administered once a day in the /159
morning on an empty stomach. During the first three days, the dose was 0.02 while on the following days it was 0.005. Dibazole began to be used as a preventive substance at the height of the flu epidemic, when the number of patients in the group increased. The results were compared with the degree of infection in other groups, where A_2 flu vaccine was used for prevention. No prevention of any kind was administered to the control group. There were no significant differences in the morbidity with regard to flu in the group which received dibazole, where no preventive measures had been taken. In the group where immunization with flu vaccine had been conducted, morbidity was half as great. While the preliminary injection of dibazole had no effect on morbidity, encouraging results were obtained in regard to the complications. The total number of complications in the group which received dibazole was half as great as in the other group. This was especially true of those complications such as otitis, sinusitis and pneumonia. Complications involving pneumonia in this group were 4-5 times less than in the other group. Results which were obtained indicate that immunization of individuals with A_2 flu vaccine considerably reduces morbidity with regard to flu, but does not prevent development of its

complications. Dibazole is worthy of attention as a substance that reduces the number of complications of flu (primarily pneumonia). Therefore, during a flu epidemic, it is desireable to prevent flu by using specific flu vaccine together with dibazole.

M. B. Umarov /160

The Problem of Neuro-Psychic Disturbances in Man Under Conditions of Prolonged Isolation at Relative Adynamia [98]

Studies were performed on two healthy men aged 35 and 39, who were kept in isolation on two occasions for 10 days each with a month interval between the experiments. During the second experiment, a cycle of physical exercises was employed.

At the end of the first period of isolation, the subjects showed signs of fatigue, as determined by objective methods of investigation of higher nervous activity. Disturbance of sleep and sleepiness in the morning were observed all during the isolation. During the morning and daytime hours, there was an inhibited state of the cerebral cortex, which caused the development on the EEG of theta-waves and a decrease in the amplitude of the biopotentials, difficulty with mental operations, deterioration of memory, simplification of associative relationships.

Beginning with the second day, euphoria developed, which was accompanied by pronounced signs of weakening of the suppressive mechanisms, and a decrease in the functions of the will. Euphoria alternated with periods of sleepiness. Together with the euphoria, there was a decline in the interest in the experiment and a natural fatigue of the subject that was linked to the maximum continuous mental stress. The period of aftereffects in one subject was about 10 days and about one day for the other.

Neuro-psychic disturbances in the experiment using physical exercises did not differ markedly in nature and type from those in the first session. The difference lay in the lower intensity of the symptoms that were observed during the experiment and in the aftereffect.

G. F. Fakhrutdinov /161

Reactions of the Peripheral Vessels of Irradiated Animals to the Effect of Certain Pharmacological Substances [99]

On the day of exposure, the ear vessels of the rabbit respond to adrenaline, pituitrin and histamine with less constriction than the vessels of a non-irradiated rabbit. At the height of the disease, the reactions to histamine decreased sharply, while those to other preparations do not change and even increase in some cases.

Ye. I. Chazov and V. G. Ananchenko

Condition of Anticoagulation Mechanism Under Conditions of Prolonged Hypokinesia [100]

To get some idea of the anticoagulation characteristics of the organism, the following were studied:

- content of free heparin in the blood;
- fibrinogen and fibrinolytic activity of the blood;
- tolerance of the plasma to heparin;
- thromboelastography according to Carter.

Three series of tests were performed involving participation of practically healthy subjects aged 19-24.

In the first group of four subjects, all of the indicators listed above were examined before and after a three-day stay under conditions of hypokinesia. In three of the subjects, there were no regular changes in the state of the thrombogenetic properties of the blood, blood heparin before and after the tests was 5-6 units/ml;

- tolerance of the plasma to heparin was 15-17 minutes;
- the level of fibrinogen in the blood was 250-300 mg %; /162
- the fibrinolytic activity was 25-30%.

Only one subject in this group had an increased heparin content -- up to 10 units/ml and an increase in the tolerance of the plasma -- up to 22 min; an increase in the fibrinolytic activity -- up to 62%.

More regular changes were observed in the second series of tests involving prolonged hypokinesia. It was found that prolonged hypokinesia in healthy individuals leads to an increase in the anticoagulating and lytic properties of the blood, leading to a decrease in the possibility of thrombogenesis.

Following prolonged hypokinesia, the fibrinolytic activity increased in three cases up to 100%, and in one case from 34 to 50%; the blood heparin content in three cases increased to 2 units/ml, while in one it remained unchanged; the tolerance of the plasma increased from 15-17 minutes to 22-26 minutes in three cases and in only one case did it decrease from 17 to 12 minutes.

In all four subjects, at the end of the period of hypokinesia, the content of fibrinogen was low (100-250 mg %).

The thromboelastograms supported the data of the biochemical tests.

Hence, the results of the studies were directly opposed to the theories which were expressed in regard to the possibility of thrombogenesis during hypokinesia. The possibility cannot be excluded that these changes have a "stressor" nature, linked to the stay of the healthy individual under unusual conditions. All of these changes must be taken into account during prolonged hypokinesia.

The data from observations made in the third series are of great interest. /163
It was found that under conditions of prolonged bed rest, healthy individuals who performed a systematic set of physical exercises showed no increase in the fibrinolytic activity of the blood or the content of free heparin. It is probable that the performance of the physical exercises during the period of hypokinesia may be a factor which will prevent the development of similar reactions involving increases of anticoagulant and lytic substances in the blood.

Ye. M. Yuganov

Physiological Reactions During Weightlessness [101]

The paper involves a study of the excitability of the vestibular analyzer in man and animals under weightlessness. The functional state of the analyzer was evaluated on the basis of data involving the study of thresholds of excitability by a galvanic current, the degree and nature of the vestibular reactions when the individual was subjected to strictly controlled angular accelerations and Coriolis accelerations.

Under the conditions of brief weightlessness, strictly regular changes developed in the indicators of vestibular reactions -- the latent period of appearance of reactions increases, while the severity of the reactions decreases. This is confirmed by a decrease in the duration of the post-rotational nystagmus, a decrease in the duration of illusion of counter rotations, a less severe manifestation of protective movements during the action of angular accelerations; an increase in the latent period of development of the "illusion of motion" and an increase in the degree of the minimum rate of rectification, causing a tilting of the trunk under the influence of Coriolis acceleration. /164

The authors suggest that under conditions of weightlessness the excitability of the receptor structures of the semicircular canal with regard to angular accelerations and Coriolis accelerations is decreased. In the authors' opinion, it cannot be linked to the direct action of weightlessness on the semicircular canals, and these phenomena are caused by changes in their receptor relationships between the semicircular canals and the otolith apparatus. The nature of the changes observed indicates that the impulsation from the otoliths during weightlessness has a much greater inhibiting effect on the semicircular canals than under terrestrial conditions. In support of these causes, there is a decrease in the "excitability" of the semicircular apparatus of the vestibular analyzer. Control experiments have shown that these changes are the result of direct action of weightlessness on the otolith apparatus, and is not the consequence of preliminary action of overloads. The authors suggest

that weightlessness does not lead to functional exclusion of the otolith apparatus, but is an unusual minus-stimulus for the otolith.

The summation of the nerve stimuli that arrives during weightlessness in the cortico-subcortical structures may lead to the development of symptoms of motion sickness in space. Characteristics of the function of the vestibular analyzer during weightlessness take the form of changes in the condition and activity of many systems in the organism.

Mechanographic and electro-myographic studies on intact, decerebrate and delabyrinthized animals as well as in experiments involving participation of human subjects demonstrated the possibility of reducing the tone of the anti- /165
gravitational skeletal musculature during weightlessness.

The influence of weightlessness in disconnecting the vestibular analyzer is reflected to a much lesser degree in the change of the tone of the anti-gravitational musculature. In experiments on animals, it was found that there was a regular decrease in the venous pressure in the right auricle and ventricle by 15-25 mm Hg from the original values. The changes in venous pressure bore a direct relationship to the decrease in tone of the skeletal musculature. The physiological changes which were observed may have been related to a direct reflex change in tone of the venous vessels. To clarify the role of this mechanism, studies of the vessels of the optical fossa were performed. By means of calibrometry with photography of the optical fossa, an increase in the diameter of the venous vessels of the retina was observed during weightlessness relative to their original state.

The changes which were observed in the venous system of the circulation are caused by dilation of the venous vessels under the direct reflex action of gravireceptors and the influence on the venous tone due to the decrease in the tone of the skeletal musculature. The absence or low level of similar changes in delabyrinthized animals indicates that the role of reflexes from the vestibular analyzer plays an important role in these mechanisms.

Under conditions of prolonged weightlessness, changes in the functions of the vestibular analyzer, the state of the tone of the musculature and the indicators of venous blood circulation may become more pronounced and affect

the working ability of the individual. The problem of the creation of artificial gravity occupies an important position in space flight as part of the measures which must be taken to maintain normal working ability of man. Studies on animals have shown that on the basis of the condition of the postural reflexes and the general motor activity, artificial gravity which develops at an acceleration of 0.3 g may be assumed to be the minimum effective value to prevent unfavorable influences of weightlessness on the motor reactions in man. /166

Ye. M. Yuganov and A. I. Gorshkov

Excitability of the Vestibular Analyzer in Man Under Conditions of Brief Weightlessness [102]

An analysis of the vestibular-vegetative disturbances that develop under the influence of weightlessness has demonstrated their absolute similarity to the clinical picture of motion sickness.

The work was performed during flights in an aircraft along a Kepler parabola, with weightlessness lasting 25-30 seconds. The experiment involved 14 men ranging in age from 20-32.

It was found that the excitability of the vestibular analyzer in man as far as angular accelerations, Coriolis accelerations and galvanic current under conditions of brief action of weightlessness is decreased.

The effect of weightlessness does not lead to a functional disconnection of the otolith apparatus. Impulsation from the otolith apparatus has a greater influence on the function of the semicircular canals than it does under terrestrial conditions.

Ye. M. Yuganov, I. I. Kas'yan, M. A. Cherepakhin and A. I. Gorshkov /167

Some Reactions of Man Under Conditions of Reduced Gravity [103]

Weightlessness is one of the specific and insufficiently investigated factors in space flight. The work of Yuganov, Kas'yan, and Gurovskiy (1961), Geratovolya (1956) et al., demonstrated the possibility of the development of unusual sensory and motor reactions in man during weightlessness. As far back

as 1911, K. E. Tsiolkovskiy wrote that under these conditions one should expect reactions having the nature of illusory sensations and distinct forms of diziness.

The authors studied the nature of the sensory reactions and the degree of change in certain indicators of motion in man under conditions of reduced gravitation.

The studies were performed aboard aircraft that were able to produce weightlessness lasting 35-45 seconds.

Results: all of the subjects could be divided into three groups on the basis of the nature and severity of the sensory reactions:

- those who withstood weightlessness well and had a sensation of satisfaction, lightness without reduction of working ability;

- those who had a feeling of falling, inverted position with the head down, rotation of the body, difficulty in excretion, complete disorientation in space and impossibility of adequate reaction to the change in the situation. After 12-15 brief sessions of weightlessness, they adapted to this condition;

- in the third group, the unpleasant sensation developed very rapidly and terminated in severe symptoms of motion sickness (fatigue, vomiting, inability to work).

Adaptation in these individuals occurred only after 20-30 sessions of weightlessness. After an interruption in the flight, the individuals in the second and third groups again felt unpleasant sensory and vegetative reactions that were characteristic of the first two flights. /168

During the stay of an individual in a condition of weightlessness, the strength of his wrists decreased from 4-22 kg, the muscle tone decreases, there is a drop in the bioelectric activity of the muscles in a state of rest. During muscular stress, the bioelectric activity of working muscles in weightlessness increases. A given muscular effort of 400 grams was maintained by the subjects without a variation of 10 grams being exceeded.

G. L. Yaroshenko, V. G. Terent'yev and V. A. Chichkin

The Problem of Medical Safety on Long Space Flights [104]

Medical safety of space flights must be based on principles of unification of the medical supplies and a reduction of their weight through replacement of the metal parts of the instruments by synthetic ones, removal of ballast substances from standard medical forms, and so on. However, even if all of these procedures are carried out, it is impossible to include all of the many medical substances which are used on Earth in the medicine cabinet onboard a spacecraft. This is by no means necessary. On the contrary, the presence of substances for rendering medical aid for ailments which simply are not encountered in space (certain chronic, endemic and age-related ailments, /169 diseases produced by the bite of insects, etc.) only complicate the use of such a medicine cabinet. The spacecraft should have aboard those medical substances which are necessary for treatment either of the most probable or of all the possible ailments and disabilities that could develop in flight. These must include changes in the endocrine system, hemodynamics, coagulation of the blood, decalcification of the bones, dehydration of the tissues, disorientation of the kinetic receptor apparatus, etc.

A sudden increase in radiation, due to the chromospheric activity of the Sun, may cause radiation damage. Although new and still unknown ailments might develop under the complex influence of space factors on a long flight, it is most likely that those ailments will develop which are encountered on Earth, especially in isolated groups of sailors and polar explorers. These people are subjected for a long period of time to extreme conditions, similar in nature to those in space, and their morbidity may serve as a starting point for prediction of the morbidity among cosmonauts on a long flight. On this basis, the probability of development of certain ailments was calculated mathematically as a function of the duration of the stay under extreme conditions (duration of the space flight) and the number of people (with male crews in mind). The calculation was performed on the basis of data regarding morbidity of polar explorers during a winter spent at the inland stations on /170 Antarctica. All of the men at the Pole underwent a preliminary medical check-up, including tests of their ability to withstand certain levels of hypoxia in

a barochamber and they were pronounced fit for professional activity. Their age was predominantly young (up to 40).

The problem of determining the probability of morbidity among the crew members on a spacecraft on a long flight was solved with the aid of a Poisson distribution, which is usually used for the study of rare events.

When using the Poisson law, the occurrence of an expected event is simulated by the coincidence of points in a given segment 1 on the axis OX. In this case, the probability of coincidence will be equal to m points in the segment 1 and is expressed by the formula

$$P_m = \frac{(\lambda 1)^m}{m!} \cdot e^{-\lambda 1},$$

where λ is the mathematical expectation of the number of points that will fall on a unit length (or the statistical probability of the event).

The probability of non-coincidence of even a single point in the given segment 1 will be equal to

$$P_0 = \frac{(\lambda 1)^0}{0!} \cdot e^{-\lambda 1} = e^{-\lambda 1}.$$

Finally, the probability R_1 that a single point will fall on the given segment is equal to $R_1 = 1 - P_0 = 1 - e^{-\lambda 1}$.

Changing now to the conditions of our problem, we can say that the probability that there will be even one ailment occurring among the crew members during a given space of time can be expressed by the analogous formula

$$R_1 = 1 - e^{-(n \cdot \lambda i \cdot t)},$$

where n is the number of crew members, λi is the statistical probability of morbidity with a given ailment; t is the given time segment. /171

The last formula is the basis for the calculations. Substituting various values for $n\lambda i$ and t, we can obtain the values of the probability of morbidity among the crew members with a specific ailment for various lengths of flight.

The probability of development of morbidity increases with increasing number of persons and the time they spend under extreme conditions. The probability of some ailments for the crew of 10-15 men tends toward unity with increasing exposure, i.e., these ailments are encountered in space under certain conditions and the cosmonauts must be ready to render medical aid when they occur. The lowest probability which must be taken into account depends (according to the "principle of practical certainty") on the danger which is posed by a specific ailment. The more dangerous the ailment, the lower the probability to be assigned to the possibility of its development and on the other hand, the smaller the threat to health and working ability posed by an ailment, the greater the possibility that it can be disregarded. For example, when a group of three men stays under extreme conditions for a period of three months, the probability of occurrence of ailments involving the heart and blood vessels is insufficiently high (0.12). Keeping in mind the seriousness of the course and the complexity of diagnosis of these diseases, we must reckon with a possibility of development of similar ailments and must consider that medical assistance will be necessary. Note that when the requrements for the /172
state of health and the functional possibilities of the organism of the cosmonauts are reduced, the investigators can increase the number of cases of ailments on long space flights and the problem of medical safety becomes more pressing for them.

The accumulation of data on the morbidity among small groups of polar explorers, submariners, involved in long autonomous voyages, researchers, cosmonauts, etc., we can see that:

a) there will be more likelihood of development of probable disruptions and ailments as well as period of their occurrence;

b) it will be necessary to provide the necessary means of combatting them;

c) it will be necessary to determine the level of preparation of cosmonauts which will be required in order to render medical assistance during flights of varying duration for crews with different numbers of men;

d) it will be necessary to determine the flight conditions under which a doctor becomes necessary aboard the spacecraft.

The method proposed may be of value in assembling the optimal medical supplies for an expedition for any purpose.

G. L. Yaroshenko and V. G. Terent'yev

Some Aspects of the Medical and Preventive Safety on Long Space Flights [105]

The prolonged influence of a group of flight factors may lead to the development of still unknown ailments, but most frequently diseases and disturbances are encountered which are also encountered on Earth. /173

To determine the most probable ailments, calculations were performed using the theory of probability. One of the most important problems of the theory of probability is the establishment of practically impossible and practically achievable events. These types of problems include the problem of determining the probability of morbidity among the crew members on a spacecraft during a long voyage.

Mathematical prediction of the most probable ailments makes it possible also to predict the times of their occurrence on long space flights. In addition to the ailments which have a certain complex of symptoms, we can expect a development of various problems that do not always show up in medical documentation and cannot serve as reliable material for mathematical prediction.

The method of scientific prediction of the probability of morbidity on long space flights must include the following basic components:

- determination of the problems and ailments which are characteristic of extreme conditions, similar in composition to the harmful factors to be encountered under conditions of long space flight;

- determination according to the theory of probability (using the Poisson law of distribution) of the probable morbidity as a function of the number of persons and the length of the flight;

- correction of the results obtained on morbidity in model experiments and morbidity under real space flight conditions.

Determination of probable problems and ailments on space flights will make /174
it possible to select the necessary minimum of medical substances to be taken along.

In view of the impossibility of surgical operations aboard modern spacecraft, when there is a possibility of surgical ailments, it is necessary to work out methods of non-operative treatment of acute surgical problems (acute appendicitis, etc.).

Medical aid on long space flights has the following tasks:

- making it possible to land the spacecraft with a sick person onboard;

- effective treatment of diseases affecting the crew members if the flight is not aborted;

- prevention and treatment of problems which may lead to development of still more severe problems.

The scope of medical self and mutual assistance must include elements of first aid, preparatory and even actual elementary medical assistance.

When there is a doctor aboard and the other crew members have been suitably prepared, elementary medical assistance may be completely feasible.

Medical preparation of the cosmonauts must involve sufficient training to perform the necessary volume of medical assistance and must include the necessary minimum of anatomical and physiological knowledge, information about possible difficulties and ailments that may crop up on long space flights as well as their differential diagnosis, medical effects of medications included in the supplies available to cosmonauts.

G. L. Yaroshenko, V. G. Terent'yev and M. N. Mokrov /176

Characteristics of Operative Intervention Under Conditions of Weightlessness [106]

In the literature available to us, we did not find any reports about surgical interventions under weightlessness conditions. Not having any answers to these questions, we cannot install aboard the spacecraft the optimum selection of medical supplies and we cannot give any correct

recommendations regarding the help to be given under critical situations. In order to study some of the problems involved, surgical operations (laparotomies) were performed on rabbits aboard an aircraft on a Kepler parabola. The operations were performed in a special transparent container under local anesthesia. The surgeon G. L. Yaroshenko was held in his seat by special straps. The working time in a state of weightlessness was about 10 minutes. The sensations and working ability of the experimenters were normal. As a result of the operations that were performed, it was established that the opening of an ampoule and the filling of a syringe with liquid contents (a 20% solution of caffeine and sodium benzoate) does not pose difficulties. The fluid does not flow out of the ampoule even with a break made rather far down (wide aperature) in the ampoule. The change in configuration of the liquid in the ampoule, characteristic of wetting liquids under weightlessness (climbing the walls with a depression in the center) does not disturb the filling of the syringe. If air enters the syringe together with the medicine (0.5% solution of novocaine), large bubbles form in the syringe which are located inside the fluid. By shaking the syringe, the bubbles can be concentrated at the needle end, but it is difficult to get them out of the syringe with the needle in place and it involves loss of medicine. When there are no /176
air bubbles in the fluid, the process of injecting the medicinal solution poses no difficulties. It was found that an increase in hydration of the tissues by means of local anesthesia in the area of the incision does not produce contamination of the cabin atmosphere. Since more pronounced eventration of the intestine occurs when the abdominal cavity is opened, there was no need to use retractors.

After the large intestine is opened, its contents remain within the limits of the incision and, gradually emerging on the surface of the serous membrane of the intestine, do not separate from the latter and do not contaminate the atmosphere. When the walls of the small intestine are cut, there is likewise no contamination of the atmosphere. In both cases, the separation of the intestinal contents from the area of the incision in the intestine did not take place. Cutting of the mesentry of the small intestine was accompanied by vigorous blood flow. The blood did not spurt out, but the flow was

significant, filling the mesentry. Under these conditions, the blood did not scatter into the atmosphere, but flowed around the injured vessels in the form of puddles. In the case of arterial blood flow, a fountain of blood broke up into droplets and scattered in all directions.

Under conditions of brief dynamic weightlessness, it did not appear possible to produce a change in the level of hygroscopicity of the bandage material (gauze). Metal surgical instruments are held in place satisfactorily by a magnet mounted beneath the level of the operating table. In addition, the instruments and the "Rekord" syringes can be held in gauze strips or on the surgical drape (fastened in a closed position, scalpels and hemostats must be wrapped in gauze). /177

The work which was performed allowed the following conclusions to be drawn.

1. Performance of operative intervention under conditions of weightlessness is possible and does not involve considerable difficulty.

2. It is necessary to consider the possibility of atomization of biological fluids that are under relatively high pressure (for example, arterial blood). To prevent contamination of the cabin atmosphere when cutting tissues rich with vessels, it is desireable to apply before hand hemostats to stop the flow of blood. With moderate blood flow, when the blood does not spurt, there is no contamination of the cabin atmosphere.

3. Local anesthesia in a state of weightlessness was demonstrated and may be used.

4. When the abdomen is opened, there is an increased eventration of the intestine. Therefore the opening of the abdomen must be performed in stages, keeping the length of the incision to a minimum.

5. When opening the lumen of the small and large intestines, contamination of the atmosphere in the cabin does not take place (this does not apply to odor).

When filling a syringe with medical solutions, intended for intravenous injection, one must be careful to ensure that air is not injected with the solution.

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